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ELECTRIC POWER FOR MINING PURPOSES.

The application of electric power to mining work has been receiving a good deal of attention abroad of late, particularly in England, where several papers have been presented before technical societies upon this topic, in which the merits of the electric motor and electric lighting for use in mines have been discussed, and the systems which have been devised for minimizing the troubles incident to the character of service required have been described.

These papers have doubtless been called forth by the important developments taking place in southern England, where several power companies have been formed and plants erected for supplying the coal-mining districts. These companies have prepared elaborate plans for distributing power over large districts from a number of power-houses connected together on extensive systems. The significance of this development lies in the fact that the power companies can generate electrical energy in a station and transmit it for some distance, and sell it to the mines at a profit, in spite of the fact that these mines are engaged in producing the fuel which the power companies must purchase. The reason, of course, lies in the fact that the electrical supply companies have built large and modern power stations, using the best apparatus obtainable, and thus produce electrical energy at a minimum cost. By means of modern appliances they can burn a poor grade of fuel and obtain excellent boiler-room economy.

There is another reason also, for while the mining company could obtain its fuel at the lowest rate, its comparatively small consumption of power will not warrant it in building a large and expensive station; and, moreover, there is a tendency apparently for the mining companies to devote themselves to their proper work of producing coal, and they find it better to purchase power from a company whose business it is to generate and sell it, rather than to be burdened with the responsibilities and troubles of running a secondary establishment.

Something of this kind has been done in this country, though to a less extent. In one instance a fine modern power-house has been constructed for supplying power to a number of mines, but in this case the mining properties are all owned by the same company, which company also has built the power station for supplying them with electrical energy. It seems probable that in this field there will be a great extension in the use of electrical power in the future.

There is another application of electricity to mining work of a somewhat different character, but in which the flexibility of electrical transmissions plays an important part. On another page of this issue is described an important hydroelectric station built by the Spring River Power Company for distributing electrical energy to the zinc and lead mines of southern Missouri. The advantages of electric power in this application are the same as those for coal-mining, but in this instance there is another factor which is even more important. The lead and zinc mines of this district do not require individually much power, and due to the character of the work, there is an uncertainty regarding the permanency of any particular mill. The deposits of zinc are of very uncertain amount, and a mill may exhaust its pocket of ore within a few months, or it may be able to maintain its position for several years. On account of this uncertainty, the practice heretofore has been to use small, inefficient, steam-driven plants for doing the work of

the mill. Realizing the unsatisfactory character of these power plants, the Spring River Power Company secured water privileges on the Spring River, Kansas, and has erected there a hydroelectric station, from which power is transmitted, by means of high-tension, three-phase currents, to transformer substations placed at favorable points within the mining district. From these substations the low-tension secondary circuits are carried to the various mills. The mills employ three-phase motors for driving their machinery. They thus obtain a more satisfactory drive and a more efficient plant. They are relieved of the fuel question entirely, and need only throw a switch to put the mill in full operation. Moreover, the character of the equipment makes it more easily transportable from place to place than was the old steam plant, consisting, as it did, of boilers and engines. The power company also has availed itself of the portability of electrical machinery, and anticipating that the centres of distribution of its districts may change, has, in two instances, constructed substations which can easily be taken down and moved to a more favorable location. It has thus been able to meet the peculiar conditions of the district, which, as already noted, call for cheap power and machinery which will not tie down the mill to any one site. This plant furnishes a very pretty example of what we are so fond of pointing out—the flexibility of electric transmission.

A WONDERFUL SOURCE OF POWER.

Probably nowhere else in the world has Nature been so lavish with water power as she has in that section drained by the St. Lawrence river. This stream drains the most magnificent group of fresh water seas existing in the world, the farthest point from the Atlantic being something over one-third of the way across the continent. The water of these lakes finds its way to the Atlantic through a series of narrow rivers, in three of which there are important falls or rapids. The first is the Sault Ste. Marie; the second—the most important—is the Niagara river; and the third is the St. Lawrence river. The first is being utilized by two power-houses, one in Michigan, and one in Ontario. The second, as every one knows, is by far the most important power centre in the world, and is being utilized by five large power-houses. The third is being developed at Massena, in New York state, and still lower down at the Lachine rapids, near Montreal. But these three localities are not by any means all the points where water power is available in this drainage basin, for there are many rivers flowing into the St. Lawrence or into the Great Lakes themselves which have considerable falls, and are thus available for power purposes. Near Montreal we have the Shawinigan falls and the Richlieu River. Ottawa also has valuable power sites within comparatively short distances. The Welland canal, forming as it does a shunt to the Niagara river, has made available considerable hydraulic power; and passing backward, we have at Chicago the drainage canal, which draws water from Lake Michigan and delivers it eventually into the Mississippi river, which has made available a considerable source of power.

Niagara falls is, of course, the most important of all of these, and has received by far the most attention. Every phase of this hydraulic development has been watched closely, and its possible effect discussed. One feature of this development is the possibility of drawing off all the water from the American fall, and in the last issue of the ELECTRICAL REVIEW this subject was discussed in an interesting way by Mr. Alton D. Adams, who analyzed what little knowledge we have of the conditions at the falls, and shows that, due to certain peculiarities, there is a possibility that the American fall may eventually become dry. The crest of this fall is higher than the crest of the Canadian fall, the branch of the river above it is narrower, and the general flow of the river is toward the Canadian side. These conditions, combined, send by far the greater part of the water over the Horseshoe fall. What proportion this is can not be said definitely, though it is certainly ninety per cent, and probably considerably more. If, then, more water be drawn from the Niagara river by the developments there, and if the possibilities of the Welland canal be fully developed, if the city of Chicago goes into the water-power business, and if the proposed cutoff canal from Georgian bay be put through, a considerable part of the water which now finds its way down over the falls will be turned aside, and the American fall may be left high and dry. Such an event would be deplorable, but the day may come when we will be able to look upon such a condition with complacency, bearing in mind, of course, the great advantage to mankind which was thereby secured. The stopping of the American fall would be the more regrettable, since we have learned that, on the whole, Niagara falls is the most wonderful water power in the world. Victoria falls, it is true, is wider and higher, but the amount of water going over the falls there is comparatively trifling, so that the power of the latter is much smaller than that of Niagara.

Mr. Adams also pointed out that New York state has water-power rights to the Canadian falls, since the international boundary line passes down this branch of the river. There are, it seems, a number of sites suitable for hydraulic developments, which may possibly be utilized some day if we are willing to jeopardize the American fall for the sake of cheap power.

It is interesting to note that the water going over Niagara falls, as was pointed out above, is utilized for power purposes at four points. The first large plant is at Sault Ste. Marie, the last is at Lachine Rapids. A short while ago a recommendation was made to utilize the rapids of the Niagara river below the falls. Then, going back to Lake Superior, there are a number of water powers on the rivers emptying into that body of water. There are thus at the present time five falls in series, and with the development of the Niagara river rapids, as suggested, there will be six points at which it is possible to imagine a body of water being passed successively through turbines to generate electric power. There is no other point on the globe where such a remarkable water system exists. The possibilities of this drainage system for power purposes are truly wonderful, and if our coal supplies fail us, as some have warned, a large body of people will become absolutely dependent upon this source of power.

PHASE INDICATORS.

A phase indicator is an instrument for showing whether the current of an electric system is in phase or out of phase with the impressed electromotive force. This instrument may be made in a number of ways, depending for its operation upon several factors. Many ingenious types of phase indicators have been described by various inventors. For example, Tuma, Korda and Arno devised instruments, the deflections of which are proportional to the angular displacement of the current with respect to the electromotive force. Puluy, Morland and Claude devised instruments whose readings vary with some function of the phase angle, such as the sine, cosine or the tangent. Another type of phase indicator is one whose deflection depends upon the product of the electromotive force and the component of current in quadrature with it—what, for a better term, has been called the "wattless power." Still a fourth type of meter indicates the wattless component of current directly. There are a large number of ways of making use of each of these functions to operate an indicating instrument, though but a few of them have been applied practically. Certain of them possess serious objections, since their sensitiveness is least when they should be most accurate.

At a recent meeting of the Physical Society, of London, Dr. W. E. Sumpner, in a paper entitled "The Theory of Phase Meters," gave a valuable study of these instruments, dealing particularly with those of the dynamometer type. It has generally been assumed that such instruments should not contain any iron, if their indications are to be accurate. For this reason the magnetic fields set up have been weak, and the instruments liable to error. This opinion, Dr. Sumpner says, is erroneous. There is no objection whatever to using iron in such meters, provided, of course, it be properly disposed and the meter properly constructed. They need not be affected by variations in wave-form or in the current frequency. The calibration of the scale is affected by the number of coils used in the instrument, by the ratio of ampere-turns used in these coils, by the distribution of the windings, and the character of the magnetic circuits; but the accuracy of the instrument is not affected by any of these factors, provided the instrument is satisfactory from a mechanical standpoint. Moreover, Dr. Sumpner showed that these instruments can be accurately and simply calibrated for a balanced load by means of the direct-current method of test. These points brought out are of much importance, for while phase meters are not of very wide use, they are of value, and a better understanding of the requirements and possibilities of design and of testing will do much toward giving the instrument a better standing, and possibly a wider field of application.

It is the little applications of the electric motor to everyday work that are rapidly making the supply of electric power one of the most important of public works. Probably to-day, in some places, at least, it stands next in importance to the supply of water. Let us hope that it will not be long before it is used as generally as water, every house depending upon it for light and power.

POPULARIZING SCIENCE.

The scientific organizations of England are fond of pointing out how much their country has done toward the advancement of that branch of knowledge. England, they say, has done more in this work than any other country; and one can not deny that there is some justice in these claims, though several other countries are pressing her closely.

But in the applications of electricity to useful purposes—engineering, as we like to call it—England, by her own confession, is behind. She has not yet squelched that relic of the rule-of-thumb days, who contends, with so much noise, that while science is a pretty thing in its proper place, it has no, or at the most, very few, practical uses, that theory is a good thing to sharpen one's wit on, but it should be dropped at the doorway of the shop. He thinks that the less he thinks about how a thing should be done, and the more he tries to find out the best way without thinking, the better will his results be, and the less will he be led astray. To his mind the only proper method of finding out whether a certain change will be an improvement or a detriment is to try it.

It would be unfair not to say that there are a large number of British manufacturers who have long since passed this stage, and who are to-day as well advanced as any one; but the old type is in the majority, and the general English public, too, seems to look upon science as a pretty thing to dabble in, but of no value to them as a people. Nor would it be fair to England to let it be assumed that such persons are not to be found elsewhere. In this country we, unfortunately, have our share, although they are being forced to the rear.

This state of affairs in England has confronted the scientific world there for some time. There are many scientific bodies which have existed there for a long time, but which have not been able—perhaps because they have not tried—to set matters right. Therefore they have formed a new society, to be known as the British Science Guild, whose purpose is to popularize science and to make the average Englishman see how important it is that he adopt scientific methods; to show him how beneficial it will be for his pocket, and to warn him that in this way only can he hope to maintain a leading place in the world. The Science Guild purposes also to extend its efforts to the British government, as well, inducing it to adopt scientific methods in all of its departments. The work of the guild is not to advance science at all, but merely to increase the public's knowledge of science.

The Science Guild has been started under favorable auspices by a large number of the most prominent British men of science, but it is difficult to see just how it will accomplish its purpose. The reading of papers at meetings of the guild can hardly be expected to do much. The public which it wishes to reach will not be there, and the press reports will probably not receive much attention. Popular lectures would be more to the purpose, yet even this method will be slow. The proper way to reach the public would seem to be through the daily press and through the weekly and monthly journals.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER IX.—*Continued.*

THE GAMMA RAYS.

A third kind of rays is given out by all radioactive substances, with the exception of polonium. It was shown by Villard in 1900, that these rays are *not deviated* by a magnetic field, and have much greater power to *penetrate matter* than either the α or the β rays. A thin film of metal is sufficient to stop the α rays. The β rays are all cut off by a piece of some heavy metal like lead that is a centimetre thick, while the kind of rays with which we are now more especially dealing can, according to Rutherford, be detected by a sensitive electroscope after they have passed through a piece of iron that is a foot thick.

These rays have not as yet been deflected to a detectable amount in the magnetic field.

While all the radioactive elements, with the exception of polonium, give off β rays, they give them out with very different intensities. It would be expected that the weakly radioactive elements—uranium and thorium, would give out γ rays to a less extent than the highly radioactive radium, and such is the fact. The gamma rays given out by the weakly radioactive elements have, however, been detected by using fairly large quantities of these substances.

The γ rays, therefore, always accompany the β rays, and this is a matter of importance in connection with the theories that have been advanced to account for the nature of the γ rays. The facts that have to be taken into account in proposing a theory as to the nature of the γ rays are: That the rays are not deflected by a magnetic field, that they have very great power to penetrate matter, and that they always accompany the β rays.

Two possible theories as to the nature of the γ rays have been proposed.

We have seen that the β rays are made up of electrons, or negative electrical charges, moving with different velocities, but all having very high velocities; the swiftest of these traveling with a velocity which is nearly that of light. It is possible that electrons are shot off from radium with even a higher velocity than that of the swiftest β rays. Such rays could have at least some of the properties of the γ rays. Their great penetrating power might be due to their increased energy produced by their greater velocity. The fact that they are not deflected in the magnetic field has been accounted for by the advocates of this theory, on the ground that the amount of the deviation being an inverse function of the velocity, the more rapidly moving particles might be deflected to such a small extent that it would not be detected. This theory contains a number of weak points. In the first place the penetrating power of the γ rays is so many times that of the β rays, that it seems difficult to account for this on the basis of the slightly increased velocity, even if the velocity of light is being closely approached. Further, if this theory as to the nature of the γ ray is correct, we might reasonably expect to find rays with penetrating power intermediate between that of the β ray, and the incomparably greater power of the γ ray. Indeed, all the intermediate stages could easily be represented. Such, however, is not the fact. The same criticism holds with respect to the deviation in the magnetic field. If γ particles are nothing but more rapidly moving β particles, and the fact that the β particles are so readily deflected in the magnetic field, while the γ particles are not deflected at all, is to be accounted for solely on the ground of the difference in velocities, then why do we not find the intermediate stages represented? This question is especially pertinent in consideration of the fact that we do know β particles with quite different velocities. The magnetic deflection of even the swiftest of these is *easily* detected. If these β particles with intermediate velocities existed, it seems reasonable to think that there would be no serious difficulty in detecting their deflection in a magnetic field.

It is, however, true that when the particle once acquired the velocity of light, it would suffer no deflection in the magnetic field. Nevertheless, the absence of these velocities renders it extremely doubtful that the γ particles are merely more rapidly moving β particles.

A theory as to the nature of the γ rays, which accounts much better for many of the facts, is the following. We have seen in a much earlier chapter, that whenever cathode rays strike a solid object X-rays are produced. We have recently seen that the β rays are essentially identical with the cathode rays. We would naturally expect that X-rays would be set up where the β rays strike a solid object. The β rays from radium strike some of the solid radium salt, or some other solid, and the gamma or X-ray is accordingly produced. The *γ ray, in terms of this theory, is nothing but an X-ray.* We have seen, however, that it has much greater penetrating power than the X-ray, and it must therefore be regarded as a *very penetrating kind of X-ray.*

This theory accounts satisfactorily for the entire absence of deflection of the γ rays in a magnetic field, since ordinary X-rays are themselves entirely undeflected by such a field. The fact that the γ rays have much greater penetrating power than the X-ray presents no serious difficulty, when we remember that the β rays which produce the γ rays have much greater velocity than the cathode ray which gives rise to the X-ray. The more rapidly moving electron would, on striking a solid object, send out a pulse in the ether with higher velocity and, therefore, greater penetrating power, than an electron moving more slowly.

This theory as to the nature of the γ rays also accounts for the fact that γ rays are always absent unless β rays are present.

Some objections have, however, been offered to this theory as to the nature of the γ rays, so that it must not be regarded as final.

SUMMARY OF THE PROPERTIES OF THE α, β AND γ RAYS.

The α rays are given off by all radioactive substances. They are somewhat deflected in a magnetic field. They have very small penetrating power, being easily absorbed even by very thin layers of matter. They have great power to ionize a gas, rendering it a conductor. The α rays ionize to about one hundred times the extent of the β and γ rays together. They have but little effect on a photographic plate, but produce fluorescence in certain substances, especially zinc sulphide. The existence of phenomena such as those manifested in the spinthariscope, are due almost entirely to the α particles. The α particle has a mass of the order of magnitude about twice that of the hydrogen ion. This, however, is only an approximation. The α particle carries a positive charge of electricity, and moves with a velocity about one-tenth that of light.

The β rays are given off from all radioactive substances, with the exception of polonium. They are very easily deflected in a magnetic field. They are absorbed by matter, but not near so easily as the α rays. They have comparatively small power to ionize a gas. They do not have great power to affect a photographic plate, and while they can produce fluores-

cence, are less active in this respect than the α particles.

The β particle has a mass about $\frac{1}{770}$ of the mass of the hydrogen ion in solution, which is the mass of the electron. The β particle carries a unit charge of negative electricity, or more accurately expressed, is a unit negative charge of electricity, shot off with an average velocity which is the same order as that of light.

The β ray is practically identical with the cathode ray in a vacuum tube, differing from it chiefly in the velocity with which the particles move.

The γ rays exist where the β rays exist. They are not deflected at all in a magnetic field. They have very great penetrating power, enough passing through a foot of iron to be detectable by the electroscope. They have much smaller power than the α particles to ionize a gas. They have considerable power to affect a photographic plate, much greater than the α or even the β particles. They produce fluorescence. The most probable theory as to the nature of the γ rays is that they are a very penetrating form of X-ray, produced by the β rays. They are, therefore, pulses in the ether, set up by the impact of the β rays on solid matter.

Influence of Electricity on Power Engineering.

At the opening meeting of the new session of the Civil and Mechanical Engineers' Society, of Great Britain, held recently, Mr. W. B. Esson, the president, delivered an interesting address on the above subject of which the following is an abstract taken from the London *Mechanical Engineer.*

The early seventies saw the inventions of Gramme and Von Hefner Alteneck, and the beginning of the electric lighting era. From these early days till now progress has been continuous. In twenty-five years the size of electric generators has increased from five horse-power to 5,000 horse-power, from the machine which fed the Jablochkoff candles in the Avenue de l'Opera in Paris, to the magnificent triumph of engineering realized in the generators at Niagara. It was not until 1880 that the first incandescent lamp factory was started on a commercial basis. From 1880 onward, power transmission made progress. Arc lighting work had taught manufacturers how to make machines for higher pressures, and the demand consequent on the invention of the incandescent lamp gave the necessary stimulus to development.

There was no such thing as transmission of power in the sense that we now understand it until the electric motor made its appearance. About 1889, engineers on the Continent were faced with a very important problem. They saw in their waterfalls thousands of horse-power running to waste. They knew that by adopting electric transmission this power could be utilized and distributed to great advantage among manufacturers scattered over a wide area, but they also recognized that success could only be obtained by the use of a pressure considerably higher than the 2,000 or 3,000 volts then in use.

The problem required a considerable amount of study, the position being: for alternating currents, pressure all right but no motor available; for continuous currents, motors available, but pressure not high enough. As the supply of power was the leading idea, the system which possessed the motor had to be chosen, and continuous current was consequently adopted, with the brilliant device, however, of joining up all the motors in series and spreading the high pressure over the lot, while connecting the generators in series to keep down the pressure on the commutators of individual machines. In this system the current is kept constant, the pressure varying according to requirements, and at the date I am speaking of it does not appear that there was any other way of providing a general power supply.

It says much for the engineering of the installations on this system that they are in most successful working to-day, and what is more, they are being added to in competition with the three-phase system. A considerable number of installations on similar lines have been laid down, some of them of great importance. Among these is the Brescia transmission of 700 horse-power at 15,000 volts over a twelve-mile line, and the larger installation for supplying La Chaux-de-Fonds with 2,400 horse-power at 14,400 volts over a thirty-two-mile line. Another installation is at work transmitting 4,000 horse-power at 22,000 volts over a thirty-four-mile line from St. Maurice to Lausanne, and there is in course of construction the largest of all, designed to transmit 6,000 horse-power at 60,000 volts over a line 114 miles long from Moutiers to Lyons.

Now, a system showing such strong vitality, though working on what nine-tenths of our engineers would call antiquated lines, can not be dismissed in a sentence. The facts are, that the system is going ahead in the face of the three-phase alternating system, and is successful on a scale commensurate with many of the larger three-phase installations. The Americans say that the success of such a system would be impossible in their country, because the motors would not there get the careful and skilled attention given to them on the Continent. This may be so, but with a large plant and substations the objection need not hold. In any case it is certain that every engineer will look forward with the greatest interest to the completion of the large scheme now in progress.

It was at the Frankfort exhibition of 1891 that the problem of long-distance transmission was satisfactorily solved. A tremendous impetus was given to power transmission in Europe, and soon a large number of installations were working on the new system, transmitting power to distances up to about fifteen miles, at pressures in the vicinity of 5,000 volts or so.

It was not until 1897 that any increase over the Frankfort pressure was made, but in that year the South California Power Company transmitted power over eighty miles at 33,000 volts. Several plants were installed at this pressure, with the object of finding out whether a still higher voltage could not be successfully employed. These experiments culminated in the Telluride company, adopting, in 1893, a pressure of 40,000 volts for its Provo transmission, and at the present time there are several installations in the States working at this pressure. The Shawinigan Water and Power Company is operating over a line eighty-four miles long, with 53,000 volts. The Washington Power Company, the California Gas and Electric Company, and the Guanajuato Power and Electric Company are all operating at 60,000 volts, while the Kern River Power Company is busy with a line on which the pressure will reach 67,500 volts. This is for the time being the highest pressure in the world, but two companies are making provision for their apparatus to be capable of working at 80,000 volts, so that whenever suitable methods of insulation for this pressure are devised they will be able to adopt it.

In Europe the pressure on transmission lines does not run high. The distances are not great, and under these circumstances it is preferred to keep the line pressure down to a figure which is possible to the generator armatures and does not require the use of step-up transformers. A most interesting example of a power installation in the Far East is furnished by the Mysore transmission of 4,000 horse-power from the Cauvery river falls

to the Kolar goldfield, a distance of ninety-two miles, at 30,000 volts. In North Wales a pioneer hydroelectric transmission installation is close upon completion which will be supplying current very soon. The power is derived from Llydaw, on Snowdon, and there will be transmitted in the first instance 4,000 horse-power at 11,000 volts for the working of light railways in the district, and for power purposes generally. A scheme which the Scotch Water Power Syndicate has in view is the transmission of 5,000 horse-power to the Vale of Leven from a hydroelectric power station, twenty-two miles distant, supplied with water from Loch Sloy, which is situated 750 feet or so above Loch Lomond Here the pressure proposed on the overhead transmission line is 40,000 volts. But the scheme is at present in the air, and whether the conductors will ever get there I would not like to say.

Unless the power transmitted is very large, the lower the pressure the better, provided that it is high enough to allow of the transmission being carried out economically. It would be folly to assert that there are no greater risks with the higher pressures, for, as a matter of fact, with pressures of 40,000 to 60,000 volts, "the highest intelligence, vigilance and excellence must be employed to avoid accident and ensure success." These pressures are not to be used indiscriminately or when they can be avoided. A large number of plants are operating at pressures between 10,000 and 20,000 volts, and of these it may be said that the overhead lines give very little trouble. The latter figure represents a voltage which can be produced in the armatures of machines of moderate size without difficulty, so this pressure may be considered a limit below which step-up transformers may be dispensed with. When we get much above this we enter a zone where we begin to experience the line troubles which very high pressures bring, without obtaining all the corresponding advantages they confer. It is very questionable, therefore, whether there should be any halting place between 20,000 volts and 40,000 volts. At 33,000 volts Dr. Perrine tells us that the special difficulties due to capacity, insulator size, erratic lightning-arrester effects, and switching begin to make themselves seriously felt, and it is just as well, if we have to redesign the apparatus with special reference to these difficulties, that we carry the pressure to the other extreme of the zone referred to, and so get the full return for our trouble. If high pressures are ever standardized, the figures for the standards will be probably twenty, forty, sixty and eighty kilovolts.

With pressures of the order of 40,000 volts, quite a new set of phenomena is brought to our notice. In the first place, the insulators, in order to prevent flashing over the supports, must be very much larger, and an increase of pressure from 20,000 volts to 40,000 volts necessitates their diameter being increased by fifty per cent or more. A usual size of insulator for the former pressure is six inches diameter, while the latter should not be less than from nine inches to ten inches, with the addition of at least one intermediate bell between the outside dome and the inside cup. When these high pressures are used the phenomenon of brush discharge has to be provided against. This results from the breakdown of the air as an insulator, owing to electrostatic strain set up in the space between the wires, and it was very thoroughly investigated by several leading engineers in America in 1893. Their experiments showed that while the loss of power due to this cause at 40,000 volts to 50,000 volts was, with the usual line construction, inconsiderable, after the higher figure was reached the loss increased rapidly. Professor Ayrton has lately worked out the distance wires of different diameters have to be placed apart to ensure that with certain pressures there shall be no brush discharge. The cure of the evil is, of course, to keep the wires far enough apart, and keep them large enough in diameter; for it is common knowledge that in the vicinity of a sharp point or a sharp edge less pressure is required to break the air down than in the vicinity of a knob or well-rounded edge. A thin wire presents along its whole length a comparatively sharp edge, and while with wires of one-tenth inch diameter 40,000 volts will discharge through about ten feet, if the wire is one-fifth inch diameter discharge will only take place when the distance between the wires has been reduced to fifteen inches. As it is usual to space the wires on a 40,000-volt line about forty-eight inches apart, and as in no lines requiring such high transmission voltage are wires likely to be less than one-quarter inch diameter, it will be seen that there need be no loss from this cause; but there is enough trouble with switches, lightning arresters, and higher pressure surges in the line without brush discharge.

It is not the high pressure that makes the trouble last mentioned; indeed, raising the pressure reduces surging, since the current is reduced with the increased pressure. Experience has shown that if a large amount of power is transmitted it is easier to operate lines at a pressure of 60,000 volts than at a pressure of 30,000 volts, because in the former case the current flowing is only about half. Suppose we are transmitting 5,000 horse-power to a distance of fifty miles at 30,000 volts. Roughly, the current in each wire will be eighty amperes, and it is possible that if this be suddenly interrupted, the surge pressure would rise to 20,000 volts. If it happened that the line was momentarily short-circuited by a lightning discharge, and that during the short-circuit four times the working current passed, the surge voltage on the removal of this short-circuit might rise to 60,000 volts, which pressure would be superposed to the working pressure. With 30,000 volts between the conductors, the pressure between any conductor and earth is 17,300 volts, so in this case the surge voltage makes the possible nearly four and one-half times the working pressure. If we worked at 60,000 volts, however, the rise on breaking the short would only be 30,000 volts, and this superposed to the working voltage gives a possible pressure of rather less than twice the working pressure. The momentary strain which insulators, transformers and other apparatus should be capable of standing is, in the case of the 30,000-volt transmission, 77,300 volts, while in the 60,000-volt transmission it is 64,400 volts. The higher working pressure has therefore the advantage, and if the power transmitted were increased the advantage would be more pronounced. It is probable that on account of this rise in pressure due to circumstances, the occurrence of which the greatest precaution will not always prevent, the current to be transmitted through each wire of long-distance transmission lines will not, as a general rule, exceed 100 amperes.

There is no hard-and-fast rule for pressures to be used, but 1,000 volts per mile is recognized as good practice. This is subject to limitation on the one hand by the highest pressures of which we have commercial experience, and, on the other hand, by the condition that the current in any wire shall not be excessive, a point which has just been dealt with. According to Mr. C. F. Scott, a distance in miles equal to three times the number of thousands of volts may be covered without incurring an excessive annual charge per horse-power for copper. This means that 5,000 volts would cover fifteen miles, 10,000 volts thirty miles, and 20,000 volts sixty miles. That 10,000 volts has reached

twenty-eight miles, and 30,000 volts ninety-two miles, is shown by the installations at work; but the solution to all engineering problems lies in compromising, and the pressure is eventually settled by striking a balance between the cost and the risks undertaken. In Great Britain the necessity for a higher pressure than 20,000 volts is unlikely to arise, at least for some considerable time.

Up to the present I have referred to hydroelectric plants only, and it is not easy to estimate the total of the water power which has been utilized all over the world by their erection. I believe I am well within the mark in placing the total capacity of the hydroelectric power-houses at work and under construction on the American continent alone at a million horse-power. In Italy, Lombardy alone accounts for 88,000 horse-power in hydroelectric power-houses at work and under construction, while Switzerland, the home of hydroelectrics, accounts for 220,000 horse-power. Taking the whole world, the water power utilized in the hydroelectric stations must lie somewhere between one and a half million and two million horse-power, a vast force, the greater part of which might have run to waste for all time had it not been for the invention of the dynamo.

All these schemes can not be placed in the same category. Cases are numerous in which electricity is employed merely as a means whereby the power of water can be conveniently parceled out to various industrial undertakings in the immediate neighborhood. Such cases furnish an example of power distribution rather than of power transmission.

It is difficult to realize what electricity has done for the mining industry. I am not thinking of its use for power distribution in and about coal mines, though on the Continent this has now attained gigantic proportions, but of the reduction in operating costs effected by the utilization of distant water power through the medium of electricity. Mines, which under the old régime could not have been made to pay, have been opened up, while those that previously had just been clearing expenses have been enabled to pay dividends. It is estimated that the Shelba mine saved £10,000 per annum by introducing electric transmission, owing to the ore being then crushed in the mine instead of transported by aerial ropeway to a mill on the bank of a river two and three-quarters miles away. At the Burma ruby mines, before the installation of the electrical transmission plant, the cost of fuel for power and lighting was £500 per month. The hydroelectric plant saved all this—£6,000 per annum—and enabled the company to begin paying dividends. By the installation of its three-phase plant, the first in the Rocky mountain regions, the Silver Lake group of mines looked to save £7,200 per annum. These are a few instances out of many. The same tale is told in all cases.

The carrying out of power schemes in Great Britain does not demand a fraction of the recourse and originality demanded of engineers carrying out power schemes in some of the American states. Here a trench is made in the ground, an insulated cable is put in, with or without bitumen around it, and so the transmission line is laid. Nothing could be simpler; but it is a very different matter carrying a pole line over the mountains in Colorado. The construction of the pole line often presents much difficulty, though many points of interest. Until recently wooden poles only had been used, but there is a growing tendency to employ for high pressures, a steel pole construction with the spans made intentionally long, so as to reduce the number of points of support. With proper care, steel poles should last at least four times as long as wooden ones, so that the sum to be set aside for renewal is much reduced, while the maintenance is also less. We shall very likely use steel poles for our power lines in Great Britain, because we produce not wood, but steel, and have a preference for things solid and lasting; but we have easy country to negotiate compared with some of the country over which power lines run abroad, a factor which is of considerable importance.

Mr. Semenza, who has done a large amount of important work in connection with the subject, has quite rightly contended that, as in a straight line with equal spans the only strain to be borne by the line is exerted by the wind, it is unnecessary to employ poles of equal resistance in all directions, and he has accordingly designed a pole which presents great resistance in the direction of the wind, but low resistance in the direction of the line. This pole is elastic, and can deflect over sixteen inches without exceeding the limit of elasticity, the consequence being that if one or two of the wires break the two nearest poles will bend, which will relieve the strain on the spans following, so that as a whole the line will stand, and no damage be done to the supports.

Needless to say, turbine construction has been influenced to a very large extent by electric power development. The design of turbines has not received much study in Great Britain, possibly because here the sphere of their usefulness is comparatively narrow. On the other hand, the subject has been studied exhaustively on the Continent, and it is to books written in another language that we must go for our information.

But if we are backward with respect to water turbines, we make up for this as regards the steam turbine, for if Britain is not exactly the birthplace of the latter, it is the country which has seen its greatest development. To-day there are 600,000 horse-power of turbines of the Parsons type at work, and in forty-two years the machine has grown from a ten-horse-power infant to a 10,000-horse-power giant. When it is remembered that the great success of the turbine has been due to the ability, energy and enthusiasm of one man, it is felt that he deserves the greatest and the best rewards that engineering has to offer.

The influence of electricity on the design of steam engines other than the turbine is undoubted. When the dynamo first made its appearance there was no high-speed engine in the market, and it was the persistent call of electrical engineers for an engine to which their machines could be coupled direct that led the late Mr. Willans to persevere and achieve such remarkable results.

Dowson, by his introduction of a heat gas, did much in the early eighties to encourage the use of gas engines, and considerable progress resulted from his work. When the possibility of burning blast-furnace gas direct in the cylinder of an engine and the economy resulting therefrom were realized, a great impetus was given to gas-engine construction. At the present time there are probably not less than 100 engines of over 500 horse-power working with cheap power gas to drive electric generators, and more large engines are made for this purpose than for any other. Already engines of 2,500 horse-power have been constructed for electrical work, and I understand that the designs are completed for the 5,000-horse-power size. Undoubtedly, engines using gas produced from cheap bituminous coal will figure largely in the electric power stations of the future.

I have not touched upon that department of power engineering which concerns itself with railways. It is only twenty-four years since the first commercial electric railway was laid down, and to-day the capital invested in street railway undertakings is something in the vicinity of £200,000,000 sterling. In Great Britain there are about 1,800 miles of electric tramways, and about 280 miles of electric railways, of which in London alone 150 miles are opened or under construction. These figures indicate great progress, but there are many fields of enterprise as yet untilled, and in closing I feel that I have but touched the fringe of a great subject. In the application of electricity to power work, engineering finds its mission of civilization as well as its greatest triumph, and the power lines disappearing in the jungle, climbing to the mountain tops, spanning the torrent, and descending to the fertile valley, bear to distant points, no less than telegraph and telephone, a message of peace and progress.

Improvement of the Grand Central Station of the New York Central & Hudson River Railroad.

EXTENSIVE improvements are now being made by the New York Central & Hudson River Railroad Company in what it terms the "Electric Zone," which comprises the territory on its main line, or Hudson division, from Grand Central station to Croton-on-Hudson, a distance of thirty-four miles, and on the Harlem division to North White Plains, a distance of twenty-four miles, the most noteworthy feature of the work being the departure from the use of steam as a motive power and the substitution therefor of electricity.

Notwithstanding the fact that within very recent years extensive improvements and additions have been made in and around Grand Central station, it has for some time been realized by the company that the existing facilities were rapidly becoming inadequate to the demands upon it, and that more room, especially in the yards, must be provided.

A large amount of real estate in the territory immediately adjoining the present yard was purchased and the buildings thereon to the number of nearly two hundred, residences, stores, apartment houses, churches and hospitals, have been with few exceptions demolished. Since August, 1903, the contractors have been engaged in the task of excavating for a subsurface yard to be thirty-five feet below the level of the present yard. The surface yard not only over the present area, but that of the newly acquired land, is being lowered to a depth of from fifteen to twenty feet below its present level, the whole involving the removal of over two million cubic yards of material, largely of rock, and in places honeycombed with gas, water and sewer pipes.

The subsurface yard, which will cover about fifteen acres, will contain 5.1 miles of tracks, and will connect by easy grades with the surface tracks at Fifty-third street. All suburban trains will enter and depart from this station, utilizing a double-track loop under the main station. By means of a direct-connection with the Forty-second street station of the Rapid Transit Company passengers may proceed on the same level to the trains of that system.

The depression of the surface yard will permit the cross streets from Forty-fifth to Fifty-sixth, inclusive, and Park avenue now closed to traffic, to be carried over the tracks by viaducts.

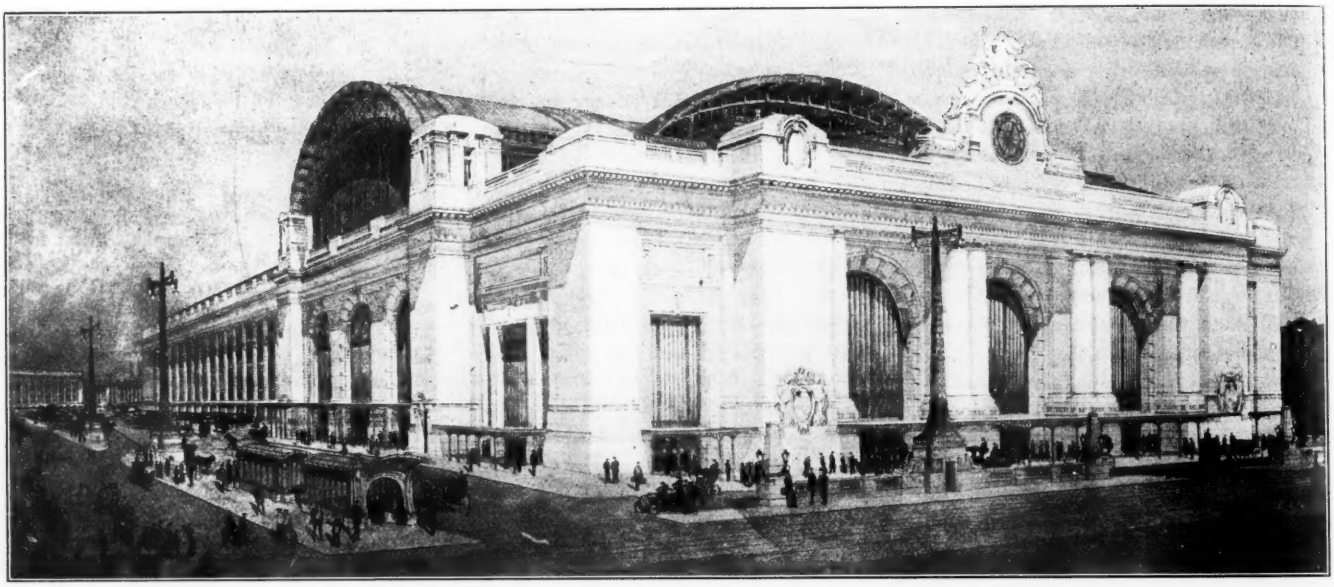
The area of the surface yard will be increased nearly twenty acres by the incorporation of the reclaimed land, which will provide for 6.2 miles of tracks. The combined area of upper and lower yards will be about fifty-eight acres, with 22.6 miles of tracks, as contrasted with twenty-three acres and 11.3 miles of tracks now available.

The surface facilities will be used for the movement of the through trains. Upon the site of the present station will be constructed an entirely new depot and railroad office building, including a branch post office and facilities for the express companies. The area to be covered by the terminal buildings is as follows: from Forty-second street north along Vanderbilt avenue to Forty-fifth street, a distance of 680 feet; thence east along Forty-fifth street 625 feet to Lexington avenue, following that street south 460 feet to Forty-third street; thence west on Forty-third street 275 feet; then south along Depew place to Forty-second street, and west 300 feet to the place of beginning.

The buildings will be set back forty feet from Forty-second street and seventy feet from Vanderbilt avenue, which with the street gives 140 feet of open space on Forty-second street and 130 feet on Vanderbilt avenue.

The main entrance will be on Forty-second street, with side entrance and exits on Lexington avenue and Depew place. The general scheme of architecture at this entrance will be three arches, each thirty-three feet wide and sixty feet high. Beyond will be the ticket-office space 90 by 300 feet. On the street level adjoining the ticket office on the right will be the outgoing baggage-room, the proximity of these two features being exceptionally convenient for the traveler.

Adjoining is the gallery overlooking the grand concourse, which will be on the



ELEVATION ON FORTY-SECOND STREET OF PROPOSED GRAND CENTRAL TERMINAL, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

level of the express tracks and will be reached from the gallery by four massive stairways each twenty-five feet wide. The concourse itself will be the largest in the world, being 160 feet wide by 470 feet long and 150 feet high, with wide entrances at each end from Madison and Lexington avenues, respectively. Adjoining the concourse will be the waiting rooms, with double the capacity of those in the present station; telegraph offices, cafés, etc.

Separate entrances will be provided for the suburban passengers with ample facilities for easily passing from one level to the other by means of broad stairways.

The suburban station will be provided with its own concourse, commodious waiting and retiring rooms, and other facilities for the comfort of the public.

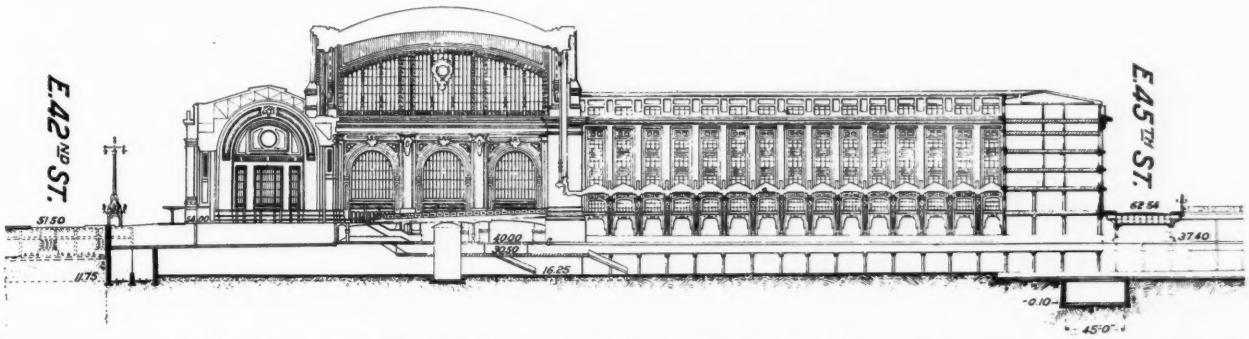
The arrangements contemplated for handling baggage are exceptionally complete, and will care for the heaviest movement without delay or congestion.

The express and post-office buildings will be equipped with every modern device for expediting the enormous amounts of such traffic daily received at and despatched from this terminal.

The frequent train service contemplated with the commencement of electrical operation renders it essential for the safety of the public and the efficient movement of the traffic that all grade street crossings within the limits of the electric zone be abolished. This will be accomplished at some points by means of overhead bridges; at others by carrying the streets under the elevated tracks. Such improvements will be made at High Bridge, Morris Heights, University Heights, Yonkers, Hastings, Irvington, Tarrytown, Ossining and other points on the Hudson division; and at Woodlawn Junction, Mount Vernon, White Plains and other crossings on the Harlem division; also at grade street crossings between Westchester avenue and Long Island sound upon the line of the Port Morris branch.

At many points new stations will be constructed, designed to meet the requirements of the heavy increase in suburban travel which has for several years been apparent, and which will undoubtedly be much greater in the future These will generally be of the overhead type. At all stations the platforms will be raised to the level of the car floors, thereby greatly facilitating the movement of passengers. The number of tracks on the Hudson division will be increased to four at all points; in many six, and in some eight. The Harlem division, which already has four tracks to Woodlawn, will be similarly equipped from that point to North White Plains. These additional tracks provide throughout the electric zone a local and an express track in each direction, thereby separating the local from the through service and facilitating the movement of both.

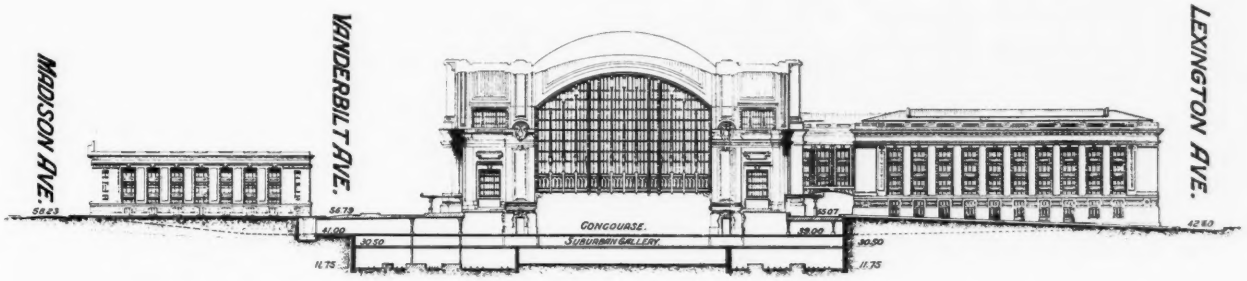
At Mott Haven, where two four-track routes will join a single four-track line, provision will be made for the elimination of all track grade crossings and a new overhead passenger station.



Longitudinal Section in Park Avenue, Grand Central Terminal, New York Central & Hudson River Railroad.

At Marble Hill, in the borough of the Bronx, an important straightening of alignment is in progress. Beginning at a point near Kings Bridge station the tracks will be carried along the Harlem ship canal and through a four-track single-arch rock tunnel 648 feet long, the first of its kind that so far as known has been constructed; and thence to a connection with the existing line near Spuyten Duyvil. This work, known as the Marble Hill cutoff, will shorten the distance three-quarters of a mile, save about two and one-half minutes in time, and eliminate seven grade crossings.

This policy of rectification of alignment will also be followed at many other points along the Hudson division, the tracks being at times carried further inland, and at others across indentations of the Hudson river. This will mean not only some decrease in distance and a consequent improvement in schedules, but it will also largely contribute to the comfort of the



Section through Concourse, Grand Central Terminal, New York Central & Hudson River Railroad.

passengers, prolong the life of both track and equipment, and reduce the cost of maintenance.

At Croton-on-Hudson and North White Plains, the northern termini of the electrification zone, facilities will be provided for the change from steam to electric locomotives for the through trains and suitable shops erected for necessary repairs to the electrical equipment.

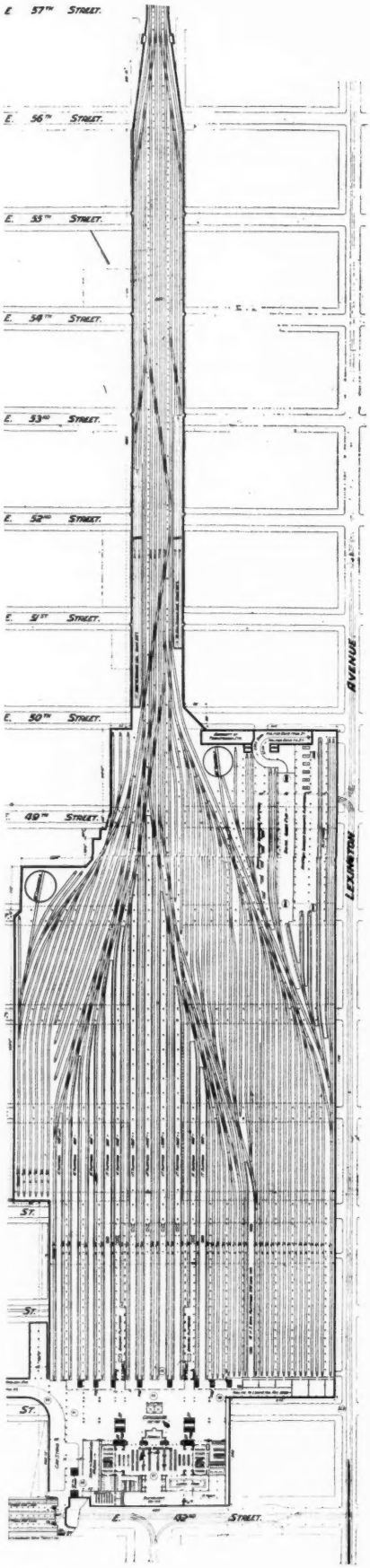
Two power-houses will be provided, one located at the end of the Port Morris branch on Long Island sound, the other at Glenwood-on-Hudson, a suburb of Yonkers. Each will have an ultimate capacity of 45,000 horse-power, or a total aggregate capacity of 90,000 horse-power. A brief description of these stations was given in the ELECTRICAL REVIEW, November 11.

The two stations will be cross-connected so that in the event of accident either station may carry the entire load. Normally, however, the Yonkers station will furnish power for the Hudson division, while the Port Morris station will supply the Harlem division.

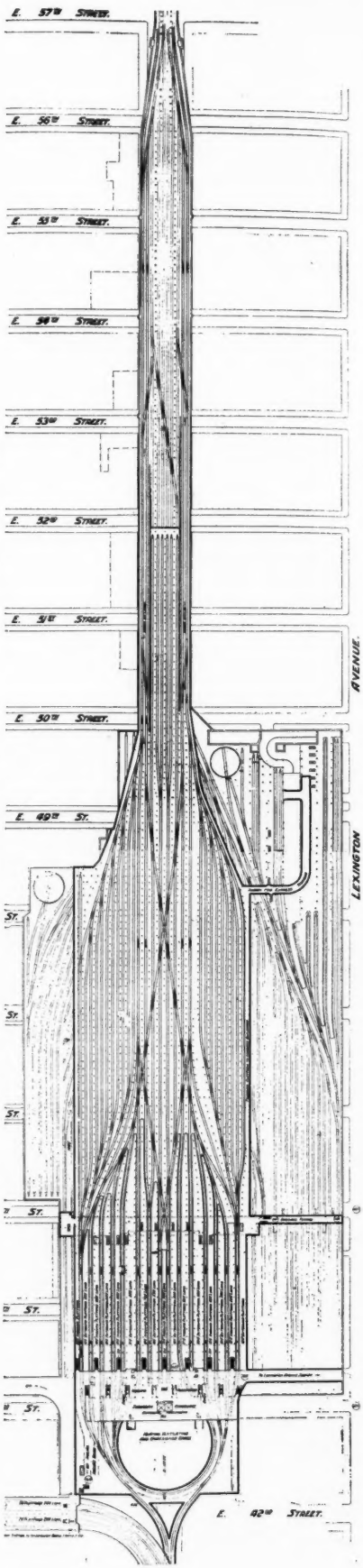
The third-rail system will be used throughout the electric zone, except at special locations, where overhead transmission will be employed. By means of a special device the contact shoe will be automatically lifted from the third rail just prior to its termination at such points, while at the same time the overhead contact will be made, thus preserving the continuity of the current. The third rail will consist of a new type known as "under contract" and will be continuously protected from contact with human beings and from interruptions due to sleet and snow.

For the movement of the through trains, powerful electric locomotives will be used, the first of which was completed in 1904, by the General Electric Company and American Locomotive Company, of Schenectady. This locomotive was described in the ELECTRICAL REVIEW November 19, 1904. In general design it is double-ended and symmetrical and can be operated with equal facility in either direction. Its total weight is ninety-seven tons, of which sixty-seven tons are on the drivers, thereby giving a much greater effective tractive effort than the present Central Atlantic steam passenger locomotive weighing 150 tons. Its normal capacity is 2,200 horse-power, with a maximum of 3,000, and its speed with a 600-ton train approximates sixty miles per hour.

At the initial test a speed of seventy-two miles per hour was reached with a train weighing 170 tons, exclusive of the



EXPRESS LEVEL, GRAND CENTRAL TERMINAL, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.



SUBURBAN LEVEL, GRAND CENTRAL TERMINAL, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

locomotive, and sixty-five miles per hour, with an eight-car train weighing 336 tons, exclusive of the locomotive.

The suburban traffic will be cared for by the multiple-unit system, thus avoiding the use of switching engines at terminals, and doing away with the present necessity for flying switches with incoming trains. Steel cars will be used, each seating sixty-four persons, lighted and heated electrically and cooled and ventilated in the hot weather by electric fans. A description of these cars was published in the ELECTRICAL REVIEW, November 4.

With a daily movement in and out of Grand Central station now averaging 640 trains, carrying 45,000 passengers (about 1,150 train movements, including storage trains and light engines), and constantly increasing, and which movement, owing to the peculiar geographical characteristics of New York city is, during the busiest hours, almost wholly in one direction, the complex nature of the problems to be solved is at once apparent, especially when it is considered that all of these important improvements, involving radical changes in tracks and structures, must necessarily be made in conjunction with the safe and regular operation of the passenger traffic of two of the principal railroad systems of the world.

The entire work involves an expenditure of approximately sixty millions of dollars, and will be completed during the next five years.

A Large Plant for Wireless Telegraphy.

Consul Diederich, of Bremen, furnishes a brief description of a new wireless telegraph station to be erected at Norddeich by the German government. Mr. Diederich writes:

The general post-office department of the German imperial government is building a wireless telegraph station at Norddeich. It is expected to cover a circuit of not less than 932 miles. This station will convey not only messages to and from Germany, Switzerland, France, Great Britain and Denmark, but also the larger part of Italy, Sweden and Norway, and even portions of Spain, the Balkan peninsula and Russia; to the southeast it will operate as far as Saragossa, in the south it will almost reach Naples and Cetinje, in the east get close to St. Petersburg, and in the north it will talk to the people at Drontheim and about half-way up to Narvik.

INSTRUCTION OF MEN OPERATING INTERCONNECTED HIGH AND LOW-TENSION SYSTEMS, WITH REFERENCE TO SAFETY OF EMPLOYES, RELIABILITY OF SERVICE, AND RESUMPTION OF SAME AFTER PARTIAL OR TOTAL INTERRUPTION.[1]

BY W. F. WELLS.

Prior to 1893 all the current distributed by the New York Edison Company was generated as required by steam-driven, low-tension dynamos. During this year the first battery was installed in Fifty-second street station. In 1896, sixty-cycle, two-phase current at 2,300 volts was transmitted from a station on the water front to the first substation located in the residence district, where it was converted to direct current by motor-generators, this being the first step taken in the New York Edison system in the direction of high-tension transmission for direct-current distribution. In 1898, 6,600-volt current from inverted rotaries was transmitted underground for retransformation, and in October, 1901, the Waterside No. 1 high-tension generating station was started. At present all but a very small proportion of the total energy is generated at 6,600 volts.

The advance from the original Edison system to the modern "Greater Edison System" has been so rapid, and the improvements and alterations in the apparatus and equipment have been so numerous, that it has been a problem to perfect and educate an organization of men capable of handling all the various branches of the interconnected system so as to ensure the same reliability of service and safety to employés as had obtained previously.

As the system increased in size and complexity, and the service from each station became more and more dependent on what occurred elsewhere, it was found necessary to broaden the organization and to raise the intellectual standard for the station operating men.

For operating the steam plant of the generating station, the high-speed stationary engineers and assistants were replaced by men trained and disciplined on the Atlantic steamships. These men quickly learned that a signal from the electrical switchboard to start or stop an engine was as imperative as an order from the pilot house, and they soon realized that when required, engines must be kept running at all hazards. They were accustomed to the operation of engines with heavy parts, were self-dependent, and have been found capable of acting promptly and with good judgment when the situation demanded it.

For the electrical operators the proposition was entirely different, the equipment being installed was of a new type, the details of which had not been fully developed, and consequently there were no men trained in its manipulation. Nor had any instruction books been printed, describing the construction of the apparatus, or its operation in connection with an electricity supply system, in a manner that would be comprehended by the men best fitted to operate it. Experience has shown that the best men for this service were those who had some mechanical training and who possessed a technical knowledge of electrical apparatus about equivalent to the steam knowledge required for licensed engineers. These men submit to the discipline and monotony of the position, by education and training become quickly acquainted with all the details of the station equipment and outside system, and in case of trouble quickly ascertain the cause and then act coolly and promptly. Their interest in the work is increased and the men induced to study and improve their condition by promoting from time to time those capable of filling positions of increased responsibility, this being partially determined by periodical examination. As a rule graduates from the technical schools have been found unsatisfactory for this class of work. As soon as they had mastered the details of the position the monotony of it would become irksome and they would secure employment elsewhere.

In the instruction of new men they are first given to understand that they are assuming certain responsibilities, that they must comply with all the rules and be conversant with all instructions issued for their guidance, and further, that if rules are not observed, action will be taken. It is only by maintaining strict discipline that best results can be obtained.

The method of instructing electrical operators varies with their positions, which, in the New York Edison Company, are graded as system operators, foremen, regulators, and various assistants.

With the system operator, experience is the teacher, and the text-books are the load curves and reports from the entire system. These are made the subject of exhaustive study and from them are deduced plans of action for the future. In

[1] Abstract of paper presented at the recent meeting of the Association of Edison Illuminating Companies.

order to be prepared to meet exceptional emergencies, which it is hoped may never occur, conditions are assumed, and operators in all stations trained and drilled in executing a carefully prearranged plan. As an instance, twice each month the steam engineers at the generating station and the foremen and electrical operators in all stations are drilled under the direction of the system operator in starting engines and rotaries from rest, as would have to be done in case of total shutdown on system. This drill, which consists in starting one and additional rotaries in the various substations, one and additional engines in the generating station, and synchronizing both rotaries and engines at low voltage and frequency, has brought out many details, such as methods of starting engines, low-voltage synchronizing devices, field excitation most suitable on generators and rotaries, the use of batteries, etc. By such means the men are trained to think and at the same time become familiar with what may be expected of them in case of serious disturbance.

A man becomes a foreman only after he is thoroughly acquainted with all the known details of the construction, operation, and repair of the apparatus. His instruction, therefore, is on the broad lines of discipline, methods of handling and educating men, thoroughness in investigation of trouble with apparatus or employés, and clearness, accuracy, and conciseness in making reports. They must maintain a certain dignity with their men, and guard against familiarity or favoritism. They should instruct their men to perform all operations and never personally operate a switch unless absolutely necessary.

For the regulators, assistant regulators, switchboardmen, brushmen, etc., it is customary to employ men for the lower grades and promote them to better positions when warranted. Each man is thoroughly trained and drilled by the foreman in the operation of the apparatus under his care and becomes perfectly familiar with all its connections before he is called upon to work on other apparatus.

As the apparatus in the stations increased and the connections became more complicated, various methods were developed in the different stations for accomplishing the same purpose. In order to avoid confusion and establish uniformity it was found desirable to issue rules and instructions for the electrical operators. In some cases it was possible to make these rules inflexible, but in other cases broad and general instructions were issued as to the methods to pursue under given circumstances, and the man depended on to use his judgment. The rules for all employés handling high-tension cables and apparatus, and detailed instructions for operating men as to the best methods to be followed in both generating and substations in case of serious disturbance to the system have been issued in booklet form to the men and their receipts taken so that no excuse can be given for ignorance. The rules and instructions for the operating men in the generating station have been collected in the form of a rule book very similar to that used on the large railway systems of the country. These are issued in a loose-leaf book, and when existing rules can not be enforced by reason of later experience, or further developments in the apparatus, necessary changes or modifications are made, as one obsolete or illogical rule tends to nullify the importance of all the others. In general this book defines the position, responsibility, and duties of each class of electrical operators; it contains concise, yet complete detailed instructions for the men in the different positions so that substitutes are fully prepared to take the place of absentees; it contains general and detailed instructions for the operation of all apparatus and for the safety of all employés working around high-tension apparatus; gives all necessary instructions for the care of batteries, with capacity table, etc.

It is impossible with a rule book, by education, or by any other means, to make a good man out of poor material, but by placing rules and instructions of this sort in the hands of intelligent men to be used as a guide, by requiring of them complete observance of the rules, and by questioning them as to their understanding of the various instructions, an organization may be developed which will successfully cope with any operating problem.

The following rules show how the Waterside station would be started in case of a total shutdown and how an interference at a substation would be handled. The rules indicate how carefully every detail has been studied and planned for so no hitch may occur in the difficult process of starting up such a large station.

In case of any accident causing a total shutdown at the Waterside station the regulator will immediately advise the engineer that all load is off, the engineer will then shut down two engines and immediately advise regulator that same are ready for service. The engineer will then "turn over" slowly all other available engines and advise the regulator that they are ready for service.

The system operator will immediately give the Waterside regulator list of feeders to be cut over to the second bus which is free or not in operation, and clear all feeders at the substations, then have 14,000 kilowatts of rotaries in substations where necessary connected to high-tension feeders, seven rotaries or the equivalent of 7,000 kilowatts connected to main bus of Waterside and a similar capacity of 7,000 kilowatts to auxiliary bus, the fields of the rotaries and one pole of the armatures to be left open.

The system operator will also advise the regulator to connect to the main bus, one of the engines shut down and the other one to the auxiliary bus, both with the fields closed and the rheostats all cut out.

When the substation regulators are ready the system operator will notify the regulator to start both engines slowly. The engineer will then start and turn these engines at the slowest possible speed at which they will revolve. When the fields of the rotaries in the substations have been closed the regulator will gradually weaken the generator field by cutting the rheostat all in.

On word from the system operator the regulator will signal the engineer to raise the speed of the engines if necessary until each engine has a load of about 350 amperes.

The regulator will then signal for another engine and synchronize it with the main bus engine and on word from the system operator signal in the regular way for increased speed until the engine has a load of 350 amperes. The engineer will not open throttle when signal lamps at throttle go out and will only give engine more steam on a signal from regulator.

The regulator will then signal for another engine and synchronize it with the auxiliary bus engine and continue putting in engines on the main and auxiliary buses in this manner until pressure is up to standard.

The system operator will advise the substation what feeder to put each rotary on so as to keep the load on the two buses balanced.

As each engine is synchronized, the regulator will not increase speed until notified by the system operator, the sys-

tem operator having first ascertained that the substations have synchronized other rotaries before giving regular word to increase speed.

The regulator in synchronizing at low speeds will use the special plug provided with candelabra lamps.

In deciding upon the number of rotaries to start in the substations the system operator will base his decision on the approximate ratio which the total load carried just before the disturbance bears to the 14,000 kilowatts available as above to start up. If the total load was 28,000 kilowatts and the available capacity to start up was 14,000 kilowatts the capacity of rotaries to be started in each substation would be one-half the load on that substation, *i. e.*, if the substation load was 16,000 amperes only 1,000 kilowatts of rotaries are to be started.

It is impossible to lay down any definite rules of procedure for substation regulators to follow in case of severe drops in pressure, or interruption of supply of high-tension current, owing to the great variety of possibilities and the different conditions affecting each substation. These instructions, which are issued for the guidance of regulators, must be studied and thoroughly understood by all men and the order in which the different operations are performed must be governed by circumstances.

If, while operating more than one direct-current bus, part of your high-tension supply is interrupted, or decreased, and you have no assurance that it will become normal very shortly, it is best to tie together all direct-current buses by closing all battery and feeder switches on both auxiliary buses. If at any time your rotary ammeters indicate that the supply of high-tension current over any feeder is discontinued, and that the rotaries connected to it have inverted and continue converting direct current into alternating current for some appreciable time, disconnect them from the alternating-current feeders, making such direct-current bus ties as may be necessary for the low-tension feeder pressure and notify the system operator that the feeder is clear. Restore pressure to normal, if possible by cutting in additional cells of battery. Keep rotaries running from direct-current end and be ready to synchronize and connect same as soon as notified by the system operator, or pilot lamp indicates that feeder is alive. In case all alternating-current supply is interrupted and is not restored before the pressure on the system has dropped to such a point that the station lighting is no more useful, transfer the station lighting supply to the main bus and open all main feeder switches. When positive that you can give no further lighting service to the system open all auxiliary bus battery switches, thus disconnecting the battery from the direct-current system, leaving it available for supplying the station lighting, the rotary fields, and all electrically operated switches and relays. Keep the system operator fully informed as to your condition. Thoroughly examine all high-tension switches and relays to make sure that they opened properly when last operated, as it might be found that the voltage at the time was not sufficient to cause them to make complete movement.

If current can be procured from outside sources some substations may receive word from the system operator to start rotaries in the usual manner on the main bus to which the battery is connected. Place the induction regulation transformer in middle position and disconnect from auxiliary buses the longest feeder, and connect same to main bus, following with the next longest feeder, etc., and picking up the short feeders last. In stations having steam plants do everything possible to get steam plant in operation. If it is found necessary to start the rotaries from the alternating-current end, the system operator will state the number of rotaries that are to be started on each feeder in each substation.

On word from the system operator connect the rotaries to be started to the high-tension feeders designated by him.

Connect one outside pole switch of the armatures of the rotaries to be started to auxiliary buses and connect the outside pole switches of the field circuits to the main bus. The field switches on the control board should be open and the rheostats at the weak or "all in" position. Notify the system operator as soon as this is done.

Waterside engines will now be started slowly.

When the rotaries have a good start close the field switches on the discharge resistance, leave them there a few seconds and then close them entirely.

Close the remaining outside pole switch of the armature of the rotary started, connecting it to the direct-current auxiliary buses to which all low-tension feeders are connected.

When the rotary so connected is about three-fourths loaded notify the system operator and get from him the number of the feeder to be made alive from Waterside and to which the next rotary is to be connected.

Start this rotary from direct-current auxiliary buses in the regular way and synchronize it (using, if necessary, the special candelabra lamps) with the feeder designated, equalize the load among rotaries and notify the system operator.

Speed of Waterside engines will now be gradually increased.

As soon as each of the rotaries running is three-fourths loaded notify the system operator.

Continue synchronizing rotaries in this manner until the system is up to standard voltage.

Tie together the bus to which the battery is connected, and the auxiliary buses to which the feeders are connected as soon as the two pressures are equal.

The Rejuvenated Sons of Jove.

The fourth Jovian congress of the Order of Rejuvenated Sons of Jove—the only fraternal organization of those engaged in the advancement of the science of electricity—was held at Dallas, Tex., October 14, 1905, at which time the following officers were unanimously elected for the ensuing year:

Jupiter, C. A. Newning, No. 2, Houston, Tex.

Neptune, L. G. Reed, No. 200, Sandusky, Ohio.

Pluto, W. M. Brooke, No. 18, Dallas, Tex.

Vulcan, J. H. LaRoche, No. 185, Cohoes, N. Y.

Mercury, C. B. Roulet, No. 213, Dallas, Tex.

Hercules, P. R. Boole, No. 155, Chicago, Ill.

Mars, F. C. R. Spence, No. 67, Marshall, Tex.

Apollo, J. P. Tufts, No. 71, Dallas, Tex.

Avrenim, W. G. Handley, No. 152, Cincinnati, Ohio.

The Order of Rejuvenated Sons of Jove was born among the leading spirits of the Southwestern Gas, Electrical and Street Railway Association at an annual convention held at Austin, Tex., in 1899. Since that time it has grown with a rapidity astonishing to its founders—who were men from many states and holding responsible offices in the electrical world, although to date its meetings have been confined to the annual association gatherings in the Southwest and in Ohio.

It is the intention of the present Jovian congress to hold its rejuvenations at the next annual conventions of the National Electric Light Association, the National Electrical Contractors' Association, the National Electric Jobbers' Association, and the Southwestern Electrical and Gas Association.

The Chicago Electrical Show.

The electrical interests of Chicago, incorporated under the name of the Electrical Trades Exposition Company, have in preparation that which promises to be the most unique, the most interesting and by far the most up-to-date show that Chicago has ever had. It will occur at the Coliseum from January 15 to January 27, and the success of the affair may be estimated from the fact that nearly one-half of the available 38,000 square feet in the big building has already been taken by the leading manufacturers and dealers in electrical appliances and apparatus who will exhibit the newest and best things developed to date in every branch of the electrical industry.

The company conducting the exposition is called the "Electrical Trades Exposition Company," and includes as stockholders seventy-five of the leading electrical men of Chicago, and is officered and managed by men well known in the electrical industries of that city.

Offices have been established at room No. 464, Monadnock Building.

Manager T. R. Mercein, of the show, is in receipt of a proposition from an eastern firm to install a chair such as are used for electrocution at Sing Sing, and also adopted by the state of Ohio. This firm does not necessarily desire to make this exhibition for the general public, but will be willing to make it a private exhibition for doctors, scientists, investigators, state legislators and officers of penal institutions.

Among the firms already assigned to space are the following:

Chicago Edison Company, Allis-Chalmers Company, Chicago Telephone Company, Frank S. Betz Company, American Steel and Wire Company, Guarantee Electric Company, Roth Brothers & Company, American Electric Company, Electrical Appliance Company, Vesta Accumulator Company, Crane Electric Company, Chicago Battery Company, Electric Storage Battery Company, Overbaugh & Ayres Manufacturing Company, Sam. J. Gorman & Company, General Electric Company, Westinghouse Electric and Manufacturing Company, Swedish-American Telephone Company, C. H. Thoradson, Monarch Electric and Wire Company, J. L. Schurman Company, Reynolds-Dull Flasher Company, Haller Machine Company, Sprague Electric Company, J. Lan Electric Company, Fort Wayne Electric Company, Osborne Flexible Conduit Company, Federal Electric Company, Peru Electric Manufacturing Company, Central Electric Company, Miller Anchor Company, Crocker-Wheeler Company, Mark Manufacturing Company, H. E. Cobb, Western Electric Company, H. T. Paiste Company, Universal Electric Storage Battery Company, McFell Electric Company, George W. Conover.

Underground Telephone between New York and Philadelphia.

The American Telephone and Telegraph Company is laying a system of underground cables, using the Pupin system, between New York city and Philadelphia, following closely the line of the Pennsylvania Railroad. This work has been going ahead quietly for some time, and it is expected that the first cable of 120 pairs will be placed in operation shortly after the first of the year.

This is the most important application of the Pupin system for improving telephonic communication and extending the cable service that has yet been undertaken, and means a very large outlay. The conduits have eight ducts in all, which will be rapidly filled with cables, should the first cable prove the success that is anticipated.

The Bell Telephone Company, of Philadelphia, is applying the Pupin system to underground service between that city and Chester, Pa., and this will probably begin operations about the same time. The Pupin system has been in use for some time in New York city, between the Cortlandt street exchange and Harlem, and also between Boston, Mass., and suburban points; but the proposed service is on a much larger scale than has yet been undertaken, and its operation will be watched with great interest by the telephone men of the world. The present installation means that some 32,000 miles of wire will first be laid, and of course this will be rapidly added to as additional cables are laid. The new service will supplement the overhead lines between New York city and Philadelphia, and will supply the different cities where it touches en route.

New York Electrical Society.

Mr. O. S. Lyford, Jr., will lecture before the New York Electrical Society, at 19 West Forty-fourth street, New York city, on Wednesday evening, November 22, on "The Electrification of the Long Island Railroad."

BOOK REVIEW.

"Traité Pratique d'Electrochimie." Richard Lorenz. Translated from the German into French by Georges Hostelet. Paris. Gauthier-Villars, Imprimeur-Libraire. Paper. 225 pages. 5½ by 9 inches. Numerous diagrams. Supplied by the ELECTRICAL REVIEW at $2.25.

This treatise on electrochemistry is intended for the student of that branch of science. The French edition, while founded upon the manual which Professor Lorenz uses in his laboratory at Zurich, is somewhat more complete. Since there is already available in German a satisfactory discussion of the newer theories, Professor Lorenz did not think it necessary to deal with this phase of the subject in his book, but limited himself merely to the description of laboratory exercises and directions for carrying them out. In the French edition, however, it seemed desirable to complete the work by adding to the laboratory exercises a discussion of the theory of the phenomena, and this has been done by the translator, who has had the collaboration of Professor Lorenz. The book consists of a series of 110 exercises planned to cover the theory discussed and the principles enunciated. The first part deals with the fundamental laws of electrochemistry; the second is devoted to the electrolysis of aqueous solutions; the third deals with the applications of electrochemistry. An appendix contains a bibliography of French books for reference, and a number of useful chemical and electrochemical tables.

The New York Electrical Show.

The Clark Electric and Manufacturing Company, 26 Cortlandt street, New York city, will make an exhibit at the electrical show to be held at Madison Square Garden, New York city, from December 12 to December 23. The company is manufacturing an insulator clamp to take the place of the old-style tie wire. Other overhead line material made by this company will also be exhibited.

The Simplex Electric Heating Company, 39 Cortlandt street, New York city, will display a wide range of electrical heating apparatus, including radiators, chafing-dishes, waffle irons, tailors' irons, coffee urns, glue-pots and incubators. These exhibits will be shown in actual operation. A model electric kitchen will be furnished, and a corps of cooks will demonstrate the uses of the products of this company, actually cooking some of the food, including the roasts which will be served in the café.

Among the novelties to be exhibited is a water-cup for boiling small quantities of water. It is claimed that this will heat half a cup of water by electricity to 150 degrees within one-half minute. Another exhibit will be a combined chafing-dish, French coffee-pot and tea-kettle, all of which may be mounted on one base. By removing the water bath of the chafing-dish, either the coffee-pot or kettle may be clamped to take its place. The exhibit of the Simplex company will be in charge of Mr. Roger Williams.

Hydroelectric Plant on the Spring River, Kansas.

Description of an Interesting Plant Supplying Electric Power to the Lead and Zinc Fields of Missouri.

THE lead and zinc fields of the state of Missouri comprise an area of about 150 square miles, extending from Galena, Kan., through Jasper County, Mo., and from South Joplin, Mo., as far as Alba and Neck City. The mining industry in this section was started in 1878, but at that time the operations were carried on for the production of lead only. Later, as the surface deposits were exhausted and the works were carried deeper, zinc was found in paying quantities, and to-day the zinc industry is far more important than the lead.

Zinc ore is found in pockets varying greatly in extent. It is impossible to predetermine the value of any particular deposit, and therefore the works for securing the ore are of a temporary character, since it may be necessary to remove them within a few months, or they may remain in position five or six years.

This characteristic of the zinc-mining industry has resulted in the adoption generally of inefficient mining machinery, consisting of small, cheap, steam-driven plants. The desirability of changing this condition and obtaining efficient operation was well recognized, and a company organized to develop the hydraulic power of the Spring river, for the purpose of generating electric current for distribution to the mining district. This company is composed of Chicago men, Mr. Francis W. Farwell being the president; Mr. Jamot Brown, the vice-president, and Mr. Samuel Brown, Jr., secretary and treasurer. The power company secured the services of the A. nold Company, of Chicago, Ill., to prepare plans and specifications for the proposed development, and later the latter company was awarded the contract for the entire construction.

The development of the Spring river consists of a power plant near Lowell, Kan., where Shoal creek flows into the river. Here a dam has been constructed, and the complete power-house built and equipped. From the power-house, transmission lines are carried through the zinc district to Galena, Joplin and Webb City, all about thirty miles distant. Four substations have been constructed, from which secondary distributing lines are carried to the mines. The voltage of the high-tension system is 33,000; that of the low-tension system is 2,300.

The dam at Lowell is constructed entirely of concrete. It rests on rock at the bottom of the river. The dam proper is about 500 feet long, but there is also an earth embankment with a concrete core, nearly 800 feet long. The dam has been constructed so as to form the power-house as well. Within it are two turbine rooms, each ninety-nine feet long, between which is the generator room, forty-five feet long and thirty feet wide. The controlling gates are located just beyond one turbine room, and occupy a distance of ninety-five feet in the length of the dam. There are five Taintor gates here for controlling the flow of water. Directly below the gates are the aprons affording a spillway. At the shore end of the earth embankment runs a roadway extending from Lowell to Varck, the grade of which has been raised for about three-quarters of a mile. About half a mile from the end of the dam a natural channel in the land affords a cutoff, through which, during flood times, part of the water of the Spring river may be diverted around the dam.

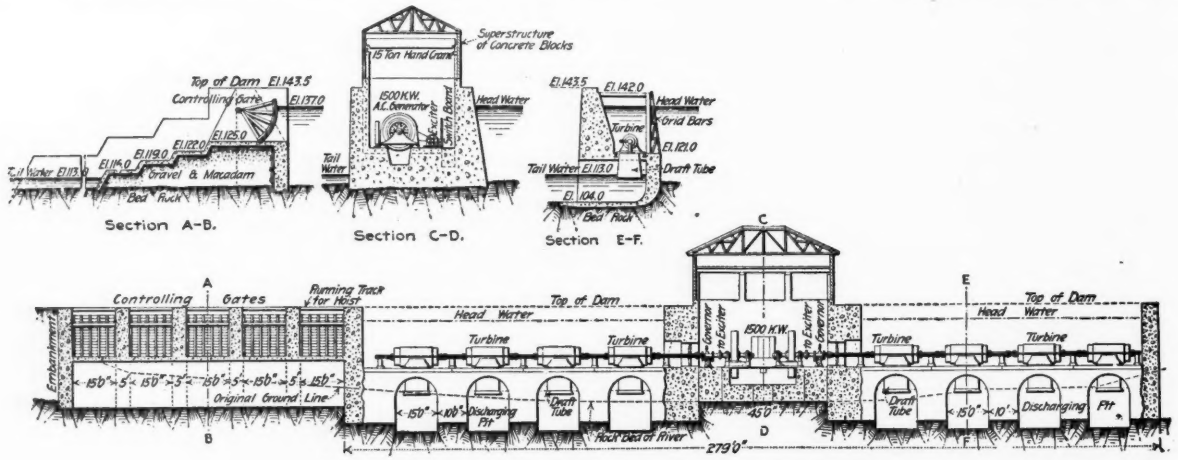
The arrangement of the dam and power-house is somewhat unusual. The normal elevation of the water in the tailrace will be about 113 feet. The floor of the turbine room is eight feet above this, and through this floor project the draught tubes of the turbines, which reach from six to twelve inches below the surface of the tailrace. The depth of the water in the race will be ten to twelve feet. The dam gives an elevation of water of about 141 feet, making available a head of twenty-eight feet. The turbine rooms are merely bays in the wall of the dam, the turbines practically resting on the bottom of the river. They are protected on the up-stream side by a grid bar-rack, supported with steel columns. This rack has been arranged so that sliding gates may be introduced in case it is desired to shut off the water to get at the turbines.

UP-STREAM SIDE OF DAM ACROSS THE SPRING RIVER, NEAR LOWELL, KANSAS.

In each turbine room are four pairs of horizontal turbines mounted on a single shaft. This gives a very simple arrangement. The turbine room is roofed with heavy planking on steel beams. The turbines were furnished by James Leffel & Company, of Springfield, Ohio. Each driving unit consists of four pairs of the improved forty-two and one-half-inch, centre-discharge, horizontal turbines. These are designed to run at from 180 to 200 revolutions per minute, and it is said that they will develop eighty per cent of the theoretical efficiency with a twenty-four-foot head of water. Each

pair of turbines are mounted on heavy base plates, which, in turn, are mounted on heavy steel beams, forming the supports for the turbine-room floor. There are two gate shafts for each set of four turbines. The end of each shaft is provided for direct-connection to a Lombard governor. Each set will develop about 2,800 horse-power at seven-eighths of full gateage, giving an available output of the station of 5,600 horse-power.

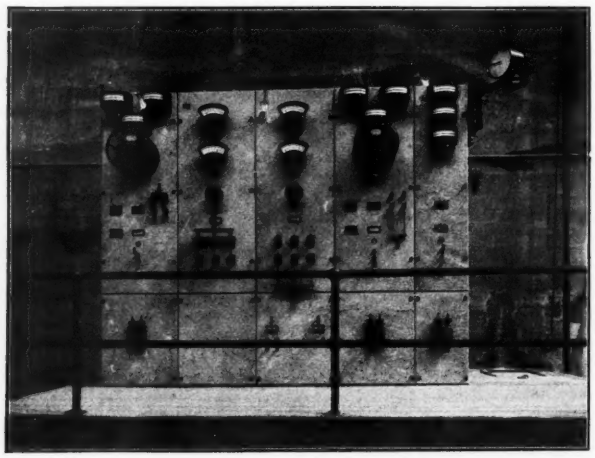
From the two turbine chambers the horizontal shafts are led through bulkheads eight feet in diameter to the generator room. The shafts are ten inches in diameter where they pass the bulkheads. The turbine gate shafts are also carried through these bulkheads to the Lombard governors, which are of the "N" type, placed beside the turbine shafts, to which they are directly belted. They are themselves each directly connected to one of the two gate shafts of a turbine set, and connected to the second by means of wire rope and sheaves. Each of these governors is provided with a pump and storage tanks for operating the controlling mechanism. The governors themselves are governed by electrical speed-controllers of Lombard design, for the purpose of enabling the speed of the turbines to be varied, so that the generators may be synchronized.



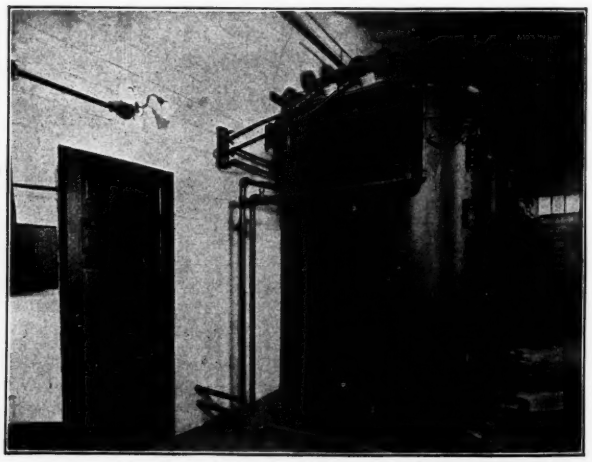
LONGITUDINAL AND CROSS-SECTIONS OF SPRING RIVER DAM.

The equipment in the generator room consists of two 1,500-kilowatt, three-phase, twenty-five-cycle, 2,300-volt, alternating-current generators, one direct-connected to each turbine shaft. The normal speed of operation is 187.5 revolutions per minute. Two fifty-five-kilowatt, 125-volt exciters are provided, one belted directly from each shaft. Besides these generators and exciters, there is in the generator room a switchboard, but no other electrical apparatus. The step-up transformers and the high-tension switches are installed in a transformer house placed on the bank of the river, fifty feet south of the south end of the dam. The field rheostats for the generators are placed in pits underneath and behind the exciter switchboard. The current and potential transformers for use with the indicating instruments are placed in pits beneath the generators. These pits also give access to the lower part of the generators, when repairs are necessary. The generator room is served by a fifteen-ton, hand-power traveling crane, furnished by the Whiting Foundry Equipment Company, of Harvey, Ill. The electrical equipment itself was supplied by the General Electric Company, Schenectady, N. Y.

From the generator room the 2,300-volt current is carried through a three-wire, paper-insulated, lead-encased cable to the transformer house, and is led directly to the low-tension side of the transformers. From the high-tension side of the transformers the current passes through type "H" oil switches and single-pole disconnecting switches to the high-tension bus-bars, and from the bus-bars through single-pole disconnecting switches and type "H" oil switches to the line. The oil switches in the transformer house are operated from the switchboard in the gen-



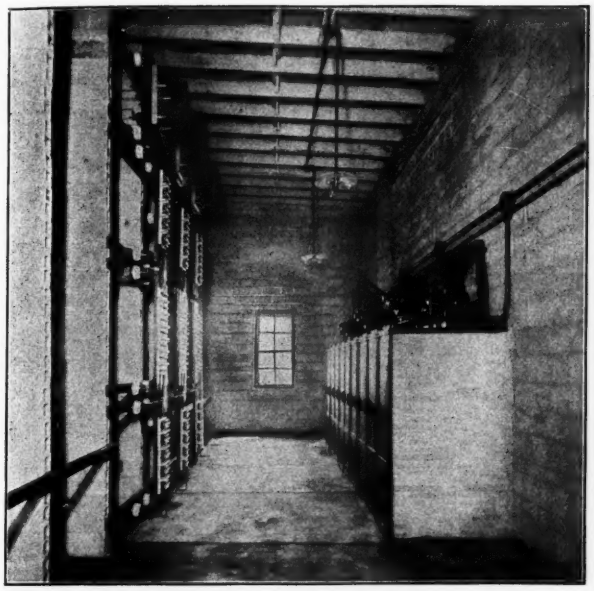
SWITCHBOARD IN GENERATOR ROOM OF SPRING RIVER STATION.



EQUIPMENT OF TRANSFORMER HOUSE, SPRING RIVER PLANT.

erator room by means of the General Electric Company's standard system of remote control. Leads are also carried back to the generator room from current transformers placed in the high-tension line.

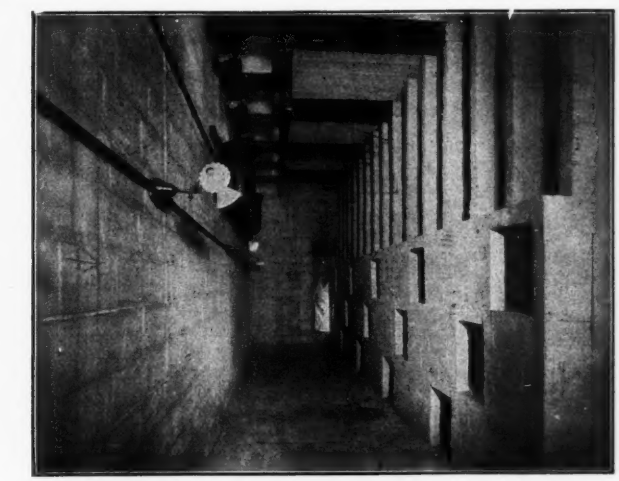
The switchboard in the generator room contains five panels. Two of these are for the exciters, on which are mounted ammeter, voltmeter, exciter rheostat and a main switch. There are two generator panels, on which are mounted ammeters, voltmeters and indicating and recording wattmeters for the two generators. These panels contain also the remote-control switches for operating the oil switches in the transformer house. The fifth panel is for the line, and contains the control switches for the high-tension line switches and the line ammeters. Provision is made for two additional line panels. A synchronizing indicator is placed on a bracket on the switchboard, and a Tirrill regulator is installed on a small bracket at the end of the board. The generator room is lighted from the 125-volt exciter circuit. Switches for these circuits are placed on the lower part of the exciter panel. All electrical connections between the generator room and transformer room are made by means of paper-insulated lead-encased cable, laid in tile ducts. The generator cable is a three-wire, 600,000-circular-mil cable, the cable for each generator being laid in a separate duct. The switch-controlling cables are two-wire, and are laid in other ducts. There is in addition a lighting circuit carried from the exciter circuit in the generator room to the transformer house.



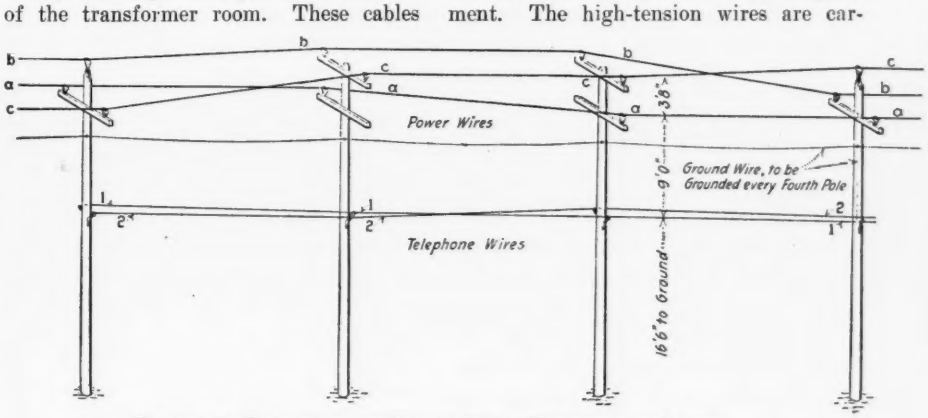
High-Tension Oil-Switches and Lightning Arresters, Spring River Transformer House.

The equipment of the transformer house consists of six 500-kilowatt, 2,300-volt to 33,000-volt water-cooled transformers, and the high-tension switches mentioned above. The lightning arresters for protecting the line are also placed here. They are of the standard General Electric type. This building is constructed of hollow tile, and is about forty-one feet long by thirty-one feet wide. That part containing the lightning arresters, oil switches and high-tension busbars is about thirty-three feet high. The part containing the transformers is separated from the other by a brick wall, and is only twenty feet high by fourteen feet wide. The 2,300-volt cables end in ordinary discharge bells, placed on the side of the transformer room. These cables lead directly to the low-tension delta, connecting with the low-tension side of the transformer. The high-tension delta is placed directly above the transformers. Connections are made by means of No. 2 bare copper wire supported on Locke No. 311 insulators. The high-tension cables pass through wall insulators, also of the Locke pattern, from the transformer room into the switch room, going directly to the high-tension oil switches. These switches are on the floor of the second story of this part of the building. The bus-bar compartment is located directly beneath the switches, and is built up of the hollow tile used in the building construction. The floor of the switch room is of concrete and steel.

The outgoing leads pass through the disconnecting and the oil switches, then along the ceiling to the opposite side of the room, thence up along the back of the lightning arresters to double-pole disconnecting switches near the high-tension entrance. The entrance to the building is made through slate panels mounted on strap-iron supports. This section of the switch house forms a wiring compartment. The high-tension wires are carried directly through an opening in the wall to a standard line insulator mounted on a bracket on the outside of the building wall. The impedance coils used in connection with the lightning arresters are formed by winding the conductor in the form of a spiral about six inches in diameter, with a half-inch pitch. These coils are placed along the wall directly



Barriers and Bus-Bar Compartments, Spring River Transformer House.



Details of Transposition, Spring River Transmission System.

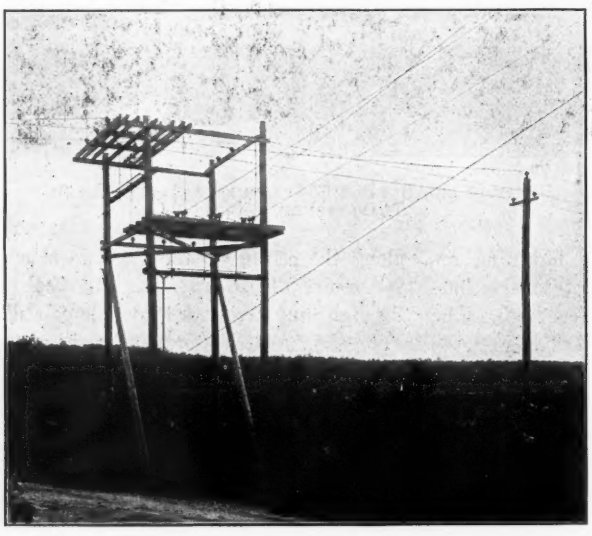
back of the arresters. At the present time there are but three oil switches installed, though provision is made for two additional. The water for cooling the transformers is drawn from the river above the dam, and forced by a small centrifugal pump through the cooling coils. This pump is driven by a two-horse-power, 125-volt motor. The discharge end of the cooling water pipe is submerged below the surface of the rail water, thus giving a difference in head sufficient, under normal conditions, to maintain the necessary circulation, but the circulating pump has been installed as a safeguard. The transmission line consists of three No. 4 bare copper wires, supported on Locke No. 311 insulators. These wires are arranged in the form of a delta, the top insulator being attached by means of an iron bridge to the top of the pole. The lower two insulators are supported on a cross-arm three and one-quarter by four and one-quarter inches by five feet long. All insulator pins are furnished with porcelain bases. The distance between wires is forty-four inches. A ground wire, consisting of No. 6 soft-drawn steel, is installed on the side of the pole, two feet below the bottom of the cross-arm. This wire is attached to the pole by means of three-eighths-inch by three-inch lag screws and washers, and runs parallel to the transmission line wires. A ground connection is carried from this wire at every fourth pole to a ground buried below the bottom of the pole. The standard poles are thirty-five feet long, with seven-inch tops, and are set six feet in the ground. This brings the lower wire of the transmission line to about twenty-six feet above the ground. The ground wire is about twenty-three feet above the ground.

The transmission line is transposed about once every mile, the number of transpositions being so designed as to make a complete turn in the delta in each section of the line. A section of the line consists of the part between the power-house and the substations, or between any two substations.

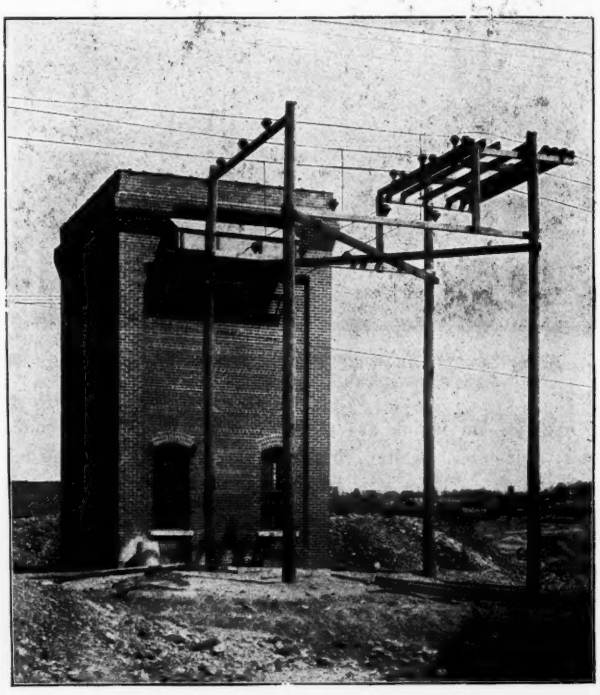
A telephone line is carried on the transmission-line poles, about six feet below the ground wire. This line is transposed every second pole, which is accomplished by means of a Locke transposition insulator placed on every other pole. This transposition has been found to eliminate practically all induction from the high-tension line. Wherever the high-tension line passes the main tracks of steam roads, special cradles are installed. These are composed of No. 4 steel wire, designed so as to prevent any broken transmission wire from reaching the ground. The cradles themselves are thoroughly grounded, so that should a wire break, the automatic oil switch at the transformer house will be immediately opened. Similar protection has been provided where the transmission line crosses other transmission lines or telephone lines. Where a telephone line is crossed at right angles, two poles have been set as close as possible, one on each side of the telephone line, thus making it impossible for a broken transmission wire to reach the telephone line.

Up to the present time four substations have been installed—one near Galena, one near Joplin, one southwest of Webb City in the Prosperity mining district, and one north of the same town in the Oronogo mining district. At each of these substations there is installed in the main transmission line a horn switch of special design, the arrangement being such that the transmission line on the side farthest from the generator plant may be cut off. This provision is made so that in case of difficulty on the line no substation between the fault and the generating plant need be put out of service. Further, by opening the switch, repairs can be made on the line beyond it without interfering with the operation of substations nearer to the generating station. The main transmission line runs through Galena to Joplin, and beyond the latter city branches, one branch line leading to the Prosperity substation, and the other to that at Oronogo. At the point of branching, two air-break switches are installed, making it possible to cut off either of the branch lines from the main line.

The substation near Galena is known as No. 1. That at Joplin is designated as No. 2. These two stations are built of brick, and are each about eighteen feet square and thirty feet high. The transmission line enters these substations in a manner similar to that in which it leaves the generating station at Lowell. There are also here lightning arresters for the 30,000-volt line, connected to the line just within the entrance. There are also three

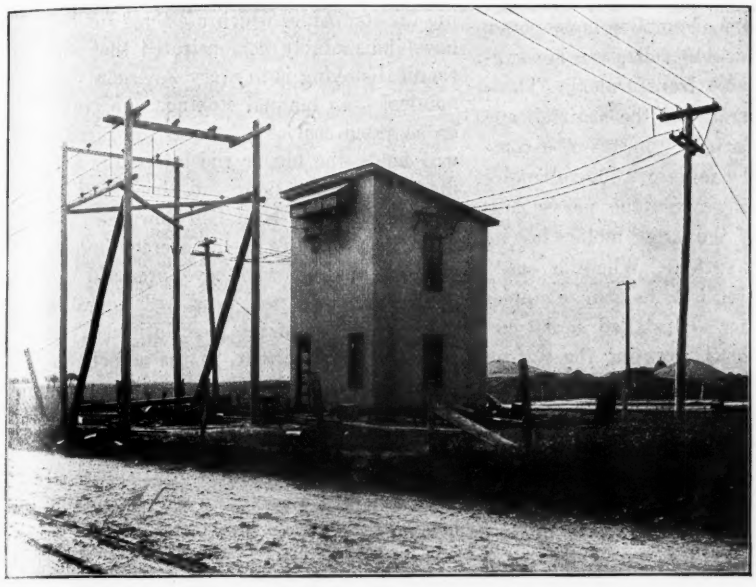


Junction in Transmission Line, Spring River Power Company.



Brick Substation No. 1, Spring River Power Company.

form "K" General Electric single-pole oil switches, provided with mechanism for hand operation. These switches are placed on the second floor of the substation. The operating mechanism is carried to the ground floor, where the controlling switchboard is located. The high-tension wires coming from the oil switches pass directly to the high-tension delta, and thence to the transformers on the first floor. There are three 250-kilowatt, twenty-five-cycle, 30,000 to 2,300-volt, water-cooled transformers in each substation.



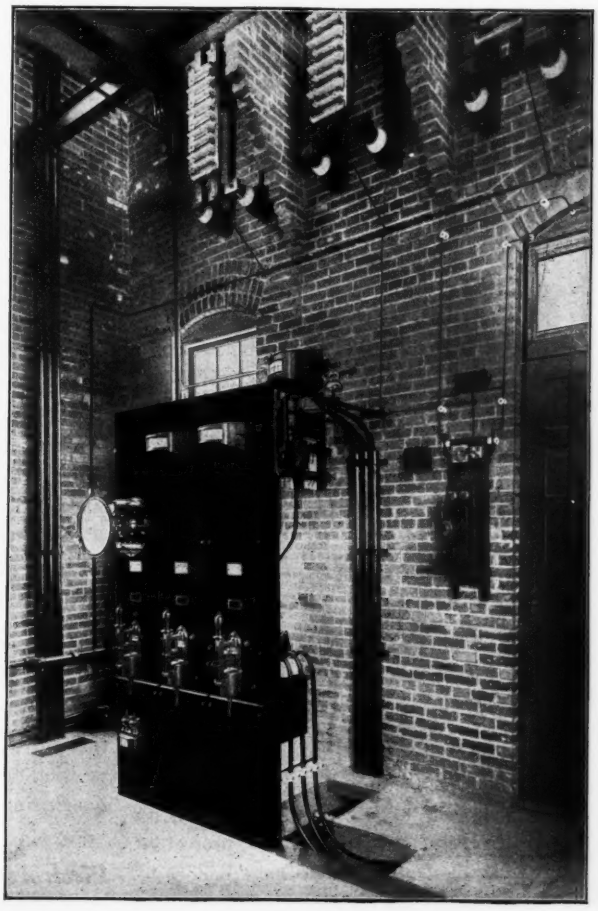
PORTABLE STEEL SUBSTATION NO. 3, SPRING RIVER POWER COMPANY.

TRANSFORMER EQUIPMENT OF SUBSTATION, SPRING RIVER POWER COMPANY.

The switchboard at these substations consists of one 30,000-volt panel, controlling the incoming line, and two 2,300-volt panels for the outgoing secondary lines. From the 2,300-volt secondaries of the transformers, leads are carried directly to the low tension delta, which is itself carried on bus-bar racks mounted in front of the transformers. From the delta, lead-covered cables lead directly to the floor and under the floor to the bus-bars on the switchboard. From the feeder line, switches and cables are carried in conduits under the floor, thence up the wall, and out through porcelain insulating tubes to the secondary distributing line.

The arrangement of apparatus in the substations is simple. In case it is desirable to disconnect the line leading from the substation beyond, or the line leading from the power-house to the substation, this can be done by means of the air-brake switch referred to above. The output of the substation is indicated and recorded by means of an ammeter and a voltmeter, and a recording wattmeter mounted on the switchboard.

Substations Nos. 3 and 4 are located at Prosperity and Oronogo, respectively. The general arrangement of these substations is similar to that of Nos. 1 and 2, but the equipment is somewhat different. In the Prosperity and Oronogo substations General Electric high-tension switches are installed, but the remainder of the apparatus, including the transformers, switchboard, lightning-arresters, etc., has been supplied by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. The buildings also are of different design. In the case of these two stations it seemed desirable to erect a structure which could be moved easily from one place to another. For this reason a light steel framework has been set up in such form as will enable it to be knocked down readily. The walls of the house are formed of corrugated iron, supported on angle iron. The roof is of wood sheathing lined with fireproofing material and covered with corrugated iron. The entire structure is mounted on concrete piers, which also carry the weight of the transformers. The only weight carried by the building is that of the oil switches mounted on the second floor, and the lightning arresters. With this arrangement it is an easy matter to take down the substation and move it to another point in the mining district, should this



TYPICAL SWITCHBOARD AT SUBSTATIONS OF SPRING RIVER POWER COMPANY.

become necessary, due to a change in the centre of distribution.

From these four substations the secondary lines are carried to the various mills supplied by the power company. These lines are supported on thirty-five-foot poles. At the top of the pole is placed a four-foot six-inch cross-arm and beneath it a four-foot two-inch cross-arm. With this arrangement it is possible to carry two three-phase lines on each pole. The secondary distributing lines consist of wires or cables, as may be necessary, in sizes ranging from No. 0000 down to No. 1. Where but one line has been installed, only the upper cross-arm is in place, and the three wires of the transmission line first installed are placed in a horizontal plane on this cross-arm. When it becomes necessary to put up the second line, the lower cross-arm will be added, and the two lines arranged in the ordinary delta manner. On the secondary lines are Locke No. 20 glass insulators, mounted on Locke No. 8 pins. The cross-arms are three and one-quarter by four and one-quarter inches in section.

A telephone line has been installed, with instruments located in each of the four substations and in the generator room and transformer house at the dam. These telephones are carefully insulated from the walls, and are provided with insulated stools, upon which the person using the instrument stands. For protection against lightning, an ordinary 2,000-volt arrester has been installed on the telephone line just as it enters the building. The line then passes through the ordinary telephone fuses and protective apparatus, and finally through a second small lightning arrester on the instrument itself. A double-pole, single-throw knife-switch is installed between the telephone and the sneak-current coil, enabling the instrument to be disconnected from the line. An extension bell is permanently connected to the line, and the usual method of operation consists in leaving the instrument itself disconnected. When a call is made from one station, the person calling rings the extension bell. The attendant at the station called then throws the knife-switch and connects his instrument to the line. This precaution has been taken to protect the instrument in case of an accident to the line.

The standard mill equipment operating on this system consists of a fifteen-horse-power hoist motor, a ten or fifteen-horse-power pump motor, and a fifty or seventy-five-horse-power mill motor. In some cases a motor rated at from 75 to 100 horse-power has been installed for operating an air-compressor. Where the rating of the motor is fifty horse-power or over, 2,300-volt motors have been chosen. These motors are protected by automatic oil switches. Motors of smaller horse-power than fifty are for 440 volts, and are supplied with suitable transformers. These motors are generally of the squirrel-cage type, and are started by means of a compensator. At the mills a 2,300-volt polyphase wattmeter records the power consumed. Each of the larger motors has its own automatic switch. Where a small amount of lighting is to be done, a single-phase transformer is installed across one phase of the circuit, lowering the voltage to 110.

The work of construction of the system has been under the direction of Mr. William H. Rosecrans, civil engineer for the Arnold Company, who has been in charge of all hydraulic features. Mr. P. L. Battey, electrical engineer of the same company, superintended all the electrical construction work. Mr. George E. Hayler, Jr., also of the Arnold Company, acted as engineering contract agent in securing the necessary data for the power installations in the mills. Later he resigned this position to become the superintendent of the Spring River Power Company.

Electrolytic Rectifiers for Telephone Stations.

It is reported in *Engineering* (London) that electrolytic rectifiers are being used for working telephones with rectified three-phase currents of 120 volts. Four aluminum cells are employed, consisting of stamped sheet-iron cases in which the aluminum plates are suspended. The electrolyte is usually sodium sulphate and sodium phosphate. The cells are connected so as to give a direct current of fairly constant voltage—about twenty. They have a resistance of 320 ohms, and require to be "formed" before use. This is done by means of a number of incandescent lamps connected in series. The electrolyte in these cells evaporates, so that refilling is required occasionally. This, when necessary, is indicated by the refusal of the incandescent lamps to become dim during the forming process. At this time the aluminum electrodes must be cleaned of the attached crystals and the cells recharged with fresh electrolyte, the salt being redissolved in distilled water.

IS MACHINE STOKING ECONOMICAL?[1]

BY ALFRED W. BENNIS.

The most careful and elaborate tests made by the manufacturers of mechanical stokers, and the engineers representing the companies which use these stokers, have indisputably demonstrated that mechanical stoking is in every way more economical than manual stoking. To crowd on as much coal at a time as the furnace will hold—the bigger the lumps the better—to shut the door and then trust to luck has already been laid down as "the main object in life of the average human stoker," and all who have practical acquaintance with the type will agree as to the accuracy of this description. It is a recognized fact that, in the actual manipulation of fires, the efficiency of the individual fireman, even of the most expert, varies widely. In order to illustrate the personal element introduced in good and bad stoking we may quote the competition which was carried out at Messrs. Davy Bros., of Sheffield. Five stokers were made to fire the same boiler with the same coal and with the steam pressure about the same. The best stoker was able to obtain an evaporation of nine of water per pound of coal, the worst evaporation being 7.4 pounds per pound of coal; the difference is here twenty-two per cent. The opportunities afforded for increasing the efficiency of the boilers were, in this instance, limited. A well-laid fire which by constant attention is prevented from burning into holes is one of the chief items in securing a high evaporation. Keeping the fire-bars clean, and regulating the dampers for a maximum quantity of air just after firing, contribute greatly to high efficiency. Beyond these points there is little opportunity for exercising skill in stoking, and yet these tests show clearly how very important the simple operations involved in firing a boiler become. The very simplicity is the one cause for neglect.

An item of great importance in deciding upon the methods of handling coal in steam-power plants is the cost of boiler-room labor. An estimate which is probably not far from accuracy is that which puts the cost of moving coal by hand or wheelbarrow at twelve cents per ton for short distances. One man, besides one night man, can run an engine and fire about ten tons of coal per week. One man, besides an engineer and night man, can fire about thirty-five tons per week. These figures do

[1] Abstract of a paper read before the Keighley Association of Engineers, York, England. Reprinted from the London *Electrician*.

not admit of the night man refusing such work as banking, cleaning and starting, and are for average conditions. When the coal has to be wheeled for long distances a fair allowance should, of course, be made. When boiler-houses are small, or by reason of their arrangement an elevating and conveying plant can not be conveniently put down, the use of small elevators is advocated—either one elevator to each boiler, or one to every two boilers. Many firms are going in for this kind of plant, including Messrs. Rowntree, of York, who are making a saving of over $10,000 per annum on an outlay of less than $6,000 for stokers and elevators, on five Lancashire boilers.

Let us now take some of the objections advanced to the use of machine-firing. Among these may be mentioned the following: (1) There is no economy. (2) The lower grade coal is not worth burning, and in any case it smokes. (3) The cost of upkeep is excessive. (4) Where the load varies machine-firing has to be supplemented by hand-firing. (5) The machine is frequently out of order. (6) Machine stokers reduce the capacity of the boiler.

Dealing with objection 1, it is customary now, with all manufacturers of first-class machinery of the kind, to install it with a guarantee of saving. The economy effected varies between twenty-five and 200 per cent on the outlay—*i. e.*, on the initial cost of the machinery.

2. With regard to this objection very many practical tests have established the claim that the work done, whether with low or high-grade coals, is practically the same. The Glamorgan Coal Company, owning one of the largest collieries in South Wales, recently made some elaborate trials of stokers and hand-firing. Hand-firing evaporated about 6,000 pounds of water per hour. The stoker on the same boiler gave, with colliery small 9,469 pounds, unwashed peas 11,142 pounds, washed peas 11,335 pounds, washed nuts and beans 10,160 pounds, unwashed beans 9,720 pounds, unwashed nuts 10,390 pounds, washed colliery small 10,684 pounds, and dry duff 8,301 pounds; so that the variation in evaporation obtained on the same boiler with these different fuels was never very great, though the price varies many shillings per ton between the best and worst of the lot, and, curiously enough, the coal which gave the best economical efficiency—the washed nuts and beans mixed—did not give the highest evaporation.

3. In answer to the third objection, it may be said that if stokers are reasonably looked after the cost of upkeep does not amount to ten per cent on the saving made by the machines. The Leeds electric lighting station has some forty machines, and their average upkeep cost comes to less than $5 per boiler per annum. The stokers at work at the lighting station in Keighley have only cost $1.93 per annum per boiler for repairs; they have been at work five years.

4. This objection may be answered by an emphatic denial that there is need for hand-firing if the man in charge knows what he is doing. In this connection it may be pointed out that machine-stoked dye-houses work without hand-firing, and the dye-house load is admittedly more variable than even the electric power-station load.

5. Against this objection we have the fact that many mills, with but one or two boilers, employ these stokers, which they could not do if constant breakdowns were the order of the day.

6. Machine-firing does not reduce boiler capacity, but increases it. In a series of tests carried out on marine boilers with hot air at the Sheffield corporation (Sheaf street) electricity works, by Mr. S. E. Fedden, the following facts, which are not without significance, were established: the rated capacity of the boilers with hand-firing was 9,000 pounds to 10,000 pounds of water per hour; with mechanical-firing and hot air 17,652 pounds of water were evaporated per hour with an efficiency of 79.9 per cent. These tests brought out most clearly the high attainable efficiency, with an increased evaporation of about eighty per cent, and this with small slack coal as against through and through by hand-firing.

Mr. J. A. Jeckell has given figures showing the results of working at the corporation electricity works, Coventry. In 1901 the station costs 6.1 cents per unit. In May two boilers were fitted with the Bennis stokers, and in October, 1902, two more boilers were fitted. In 1902 the costs went down to 4.86 cents. In 1903, when the costs were affected by the change in the stoking, the station costs went down to 3.02 cents. In 1904 they went down to 2.32 cents. In 1904 two more boilers were fitted with these machines, and in 1905 the Coventry cost stands at 1.70 cents, which is a world's record.

A most important point, which up to now has been entirely lost sight of, accounts for high efficiencies having been obtained by what I might term high-speed stokers burning a lot of coal and doing heavy evaporations. The rate of transmission of heat varies as the square of the difference of temperature between the water and the furnace temperature, and so it happens that, other things being equal, the hotter the furnace the more efficient the boiler. It is, therefore, advisable to work with as little excess of air as possible, but not a fraction too little, or down comes the temperature. It is important if good results are to be obtained to see that the air supply is properly distributed over the furnace. A self-cleaning furnace is essential, and one in which a controllable supply of air is arranged for is imperative; otherwise it becomes impossible to adjust the conditions to the best advantage.

Meeting of the American Society of Mechanical Engineers.

The fifty-second meeting of the American Society of Mechanical Engineers will be held in New York city during the first week in December. The headquarters, instead of being at the society house, 12 West Thirty-first street, as in previous years, will be at the Edison Building, 44 West Twenty-seventh street, the two upper floors being used.

The opening session, at which President John R. Freeman will present the annual address, will be held on Tuesday evening, December 5.

The second or business session will be held Wednesday morning in the main saloon of the steamship Amerika at the docks of the Hamburg-American Line at Hoboken, N. J.

Following this session a special train will take those desiring to make the excursion to the new Henry R. Worthington Hydraulic Works, at Harrison, N. J.

Wednesday evening there will be an illustrated lecture at 44 West Twenty-seventh street by Professor R. W. Wood, of Johns Hopkins University, on "Photography of Invisible Phenomena."

The third session will be on Thursday morning at 44 West Twenty-seventh street, and besides the presentation of professional papers there will be a discussion on the subject of bearings.

Thursday afternoon there will be a reception at the New York School of Automobile Engineers, 146 West Fifty-sixth street.

The usual reception at Sherry's will occur on Thursday evening.

The closing session will be held at 44 West Twenty-seventh street on Friday morning, and will be devoted to the presentation of professional papers.

Electrical Patents.

Harry P. Davis and Theodore Varney, of Pittsburg, Pa., are the joint inventors of a suspension device for trolley conductors, the patent obtained on this invention having been assigned to the Westinghouse Electric and Manufacturing Company (No. 803,216, dated October 31, 1905). The invention relates particularly to

SUSPENSION DEVICE FOR TROLLEY CONDUCTORS.

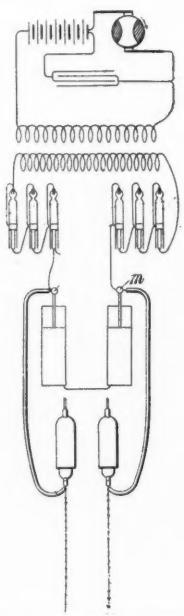
means for suspending the trolley conductors which are utilized for conducting current along electric railways. The object of the invention is to provide a simple, easily applied and substantial means for suspending a trolley conductor from a pair of messenger wires or cables. The inventors employ two messenger cables located side by side and at approximately the same elevation. A triangular frame is provided, comprising two suspension rods and a span rod. Two-part clamps fasten the messenger cables, the suspension rods and the tie rods together, and another two-part clamp is employed for fastening the meeting ends of the suspension rods to the trolley conductor.

Isidor Kitsee, of Philadelphia, Pa., has secured a patent on a transmission of electric currents (No. 803,110, dated October 31, 1905). The invention relates to

TELEPHONE SYSTEM.

a system for the transmission over long distances of fluctuating or varying electric currents or current impulses, and has particular reference to such complex currents as are characteristic of telephony, though the invention is equally applicable to telegraphy and other arts. The invention resides in a system in which the so-called "out-going" and "return" lines of conductors are, in effect, composite conductors, consisting of conductors which are conductively independent of each other, but inductively related. Such lines of composite conductors are formed by twisting a plurality of conductors together into intimate relation, so as in effect to form a mechanical unit suitable for enclosing in a cable, aerial, subterranean or submarine. The twisting, however, is an essential element of the invention, and upon it depends the efficient electrical behavior of the system.

A means for producing high-potential electrical discharges has been patented in this country by Oliver J. Lodge, of Birmingham, England (No. 803,180, dated October 31, 1905). The invention relates to the deposit of smoke, fume, mist,



MEANS FOR PRODUCING HIGH-POTENTIAL ELECTRICAL DISCHARGES.

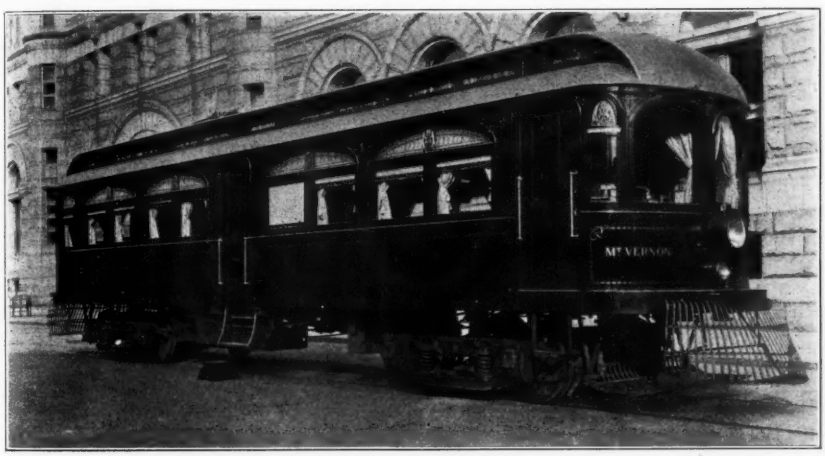
fog and the like by electrical discharges, and also in means for producing a continuous high-potential discharge of electricity in one direction only, and for the purpose of causing small particles to coalesce into larger ones, and for other purposes. In 1884 Mr. Lodge published a discovery which he had made that the discharge of electricity into the air had the effect of causing small particles to coalesce into larger ones, so that they were either made to fall more rapidly or to deposit upon adjacent surfaces in the neighborhood of the discharging points or flames or other means by which the electricity passes from solids into a gas or vapor. Now this property of the electric discharge of causing the coalescent deposit of matters suspended in a gaseous medium has many possible applications—such, for example, as the clearing away of fog or mist or the deposit of useful fumes in a closed chamber—such, for example, as lead fumes in the manufacture of white lead by furnace processes—or again, the possible use in the electrifying of clouds to produce rain by causing the mist particles to coalesce, or, indeed, it may even be possible to affect the weather in some localities by the discharge of electricity of suitable sign into the atmosphere on an extensive scale, for example, positive electricity for fine weather, and negative electricity for wet. The reason for the coalescing of the particles is that the particles become electrified or polarized by the discharge and attract each other, forming larger particles, or are attracted to opposite poles. Now the discovery above mentioned has not come into practical use on account of the difficulties attendant on the use of the statical electric apparatus, such as Voss or Wimshurst electrostatic machines employed for supplying electricity, this class of apparatus being too delicate and easily upset for use on an extensive scale. The present invention, therefore, has for its object to provide means for maintaining the high potentials necessary for the successful application of this principle without requiring the use of delicate and uncertain electrostatic machines. The invention consists in means and arrangements whereby the current from a dynamo, either a continuous or an alternating dynamo, is so transformed and treated as to give a practically continuous high-potential discharge in one direction only. It also consists in a combination of high-potential rectifiers sometimes arranged in quadrilateral groups of four or multiples of four, but always in such a way that instead of the reverse pulses being suppressed or non-existent, as at present, they are redressed to form the positive and negative discharging streams required for the deposit purposes.

Noon-Hour Opportunities for Railroad Men.

The Pennsylvania department of the Railway Young Men's Christian Association has arranged a fine series of lectures to be given to the employés of the Pennsylvania Railroad, at the Pennsylvania shops, at Columbus, Ohio, during the noon hour. This educational and religious work, it is announced, is having a considerable influence in the discipline and encouragement of the men in all departments of the railroad work. On Wednesday noon, November 15, a stereopticon lecture was given, entitled "Lightning and Electricity of the Air."

A Handsome Buffet and Parlor Car.

The Washington, Alexandria & Mount Vernon Railway Company operates a system of electric railways through one of the most picturesque and historic regions of the Southland. Along the shores of the Potomac, through old Virginia, one line goes to Alexandria, eight miles from Washington, D. C., the scene of many stirring events in the early history of the United States, and where at present there still exist many historic relics of Revolutionary days. Another system goes through Alexandria and on to Mount Vernon, sixteen miles south of Washington, where are preserved the homestead of George Washington, the family tomb, and the beautiful estate overlooking the Potomac. Another division reaches Arlington, where 16,000 soldiers who died during the Civil War are buried in the National Cemetery. Here also are consecrated battlefields and a score of monuments erected to the memory of the heroes of the Civil War.



BUFFET CAR RUNNING ON THE LINES OF THE WASHINGTON, ALEXANDRIA & MOUNT VERNON RAILWAY COMPANY.

These historic points attract a large portion of the daily tourist traffic of the national capitol, and the scheduled trains are always comfortably filled with outgoing and returning travelers. The company has now placed in commission a handsome buffet and parlor car, designed for the accommodation of chartered parties, and to run on any of the divisions.

The car, which is forty-five feet over all, is divided into a parlor and a buffet section by a full vestibule in the centre, from which ingress and egress are had to either compartment. Each section has a seating capacity for eighteen persons, and the parlor section is fitted with settees, easy chairs, wicker and basket divans. A well-appointed toilet-room supplements the other equipment of the parlor section.

In the buffet section are seats and tables and a well-equipped wine-closet, ice-chest and pantry. The porter's closet is equipped with a signal box and dial indicator and is called from both the tables in the buffet section and the chairs in the parlor section. The furniture in the buffet section is weathered oak, mission style, and the prevailing color is Nile green, and natural mahogany. The marqueterie embellishment and the carving are particularly well done, and with the striped chintz curtains and cathedral glass roof-lights and window-heads, the interior of the car presents a strikingly attractive effect.

The car is equipped with three enclosed arc lights fitted with opalescent globes. There are also ninety-two frosted bulb incandescent lamps, of various voltages and candle-power, arranged upon several groups of circuits. The lamps are fitted into ornamental sockets of a tulip design and help out the decorative scheme.

The motor equipment consists of two thirty-five-horse-power Westinghouse motors, type K-11 controllers, the Standard Traction Brake Company's air-brake system, Christensen motor-drive air-compressors, and the controller handle is equipped with the "Automotoneer," made by the Garton-Daniels Company, Keokuk, Iowa.

The motorman's cab, in either end of the car, contains, in addition to the controlling apparatus and brake-lever, a two-way switch-plug for establishing either the conduit or trolley connection. The city portion of the system is of the open-slot construction, with overhead trolley in the country. A bank of snap switches for controlling the lights is also located in the motorman's cab, and there are also a push-button and bell circuit by which signals may be sent from one end of the car to the other. The track-sanding boxes are air-controlled, and the car is fitted with electric heaters of the Consolidated Car-Heating Company, Albany, N. Y.

The car is finished outside in deep purple and gold leaf, and due to the excellence of its appointments and the attractiveness of the route will, no doubt, be a decidedly successful innovation.

The Production of Petroleum in 1904.

The production of petroleum last year was greater than that of any previous year. The total output of crude petroleum in the United States in 1904 was 117,063,421 barrels. The total value of all the petroleum marketed in the United States in 1904 was $101,170,466. The gain over the production of 1903 was 16,602,084 barrels in quantity and $6,476,416 in value.

Two new conditions stand out in the mass of facts contained in the data which Mr. F. H. Oliphant, the author of the United States Geological Survey's report, has collected. The most important of these is the fact that for the first time in the history of the petroleum industry the quantity of oil produced west of the Mississippi river was greater than that produced east of that river.

All indications point to an increase in the production of petroleum in the United States for a series of years. Most of the petroleum produced in these western localities is, however, inferior in quality. It is not suitable for the manufacture of the most refined products, but its high heating value and its freedom from the more volatile constituents render it comparatively safe to transport and consume and make it a most valuable fuel.

The second notable fact revealed in this last petroleum report is that the automobile would seem to have set the pace for the rise in the demand for refined petroleum.

The Ohio Society of Mechanical, Electrical and Steam Engineers.

The eleventh annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers was held on Friday and Saturday, November 17 and 18, in the City Hall Building at Canton, Ohio. In addition to the address by the president, a number of papers were read, and topical discussions undertaken on various subjects. The visiting delegates inspected the plant of the Buckeye Engine Company, Salem, Ohio, and the Morgan Engineering Company, Alliance, Ohio.

Reviews of Current Engineering and Scientific Literature.

Telephone Engineering in Arizona.

A graphical description is given here by Mr. Geo. B. Ellison, of the surveying and erecting of a telephone line for the government through difficult country in Arizona. The line was run from the Arizona dam to the Tonta basin in the upper dam. This is only eighty-six miles, yet the work was exceedingly difficult. The country is rough, at points almost impassable, and at times days were required for the engineers to locate but a mile or two of the line. Ten stations were called for. Four of these are to be arranged as test stations. Stromberg-Carlson telephones were agreed upon by the government. From Arizona dam to the Tonta basin the contract provided for iron poles, with eighteen-inch cross-arms. All the lines were full metallic circuit, transposed four times to the mile. When possible, thirty-five poles were to be set in each mile. This was seldom possible. The details of the line were left largely to the engineer and to circumstances. The contractor secured a large number of discarded boiler tubes for the poles. These were flattened out at one end, and drilled for lag-screws for attaching the cross-arms. The poles were set in concrete, the lower end being dipped in asphaltum. Where the line crossed the government road it was required that the wires be sixteen feet from the ground. As none of the boiler tubes was over sixteen feet long, a spliced tube was made by setting a three-inch tube as usual. This was filled with packed sand to within four feet of the top, and covered with an inch of cement. Then a two and one-half-inch tube was cut to the proper length, slipped into the three-inch tube, and run around with the cement. This made an excellent job. Many long spans, varying in length from 800 to 1,500 feet, were necessary. The construction of these spans was made up of two three-inch tubes set side by side six feet apart, with two cross-arms bolted on with U-bolts. The span-wires were three-eighths of an inch galvanized steel strand, one taken across the top cross-arm, and one on the bottom arm, resting on iron saddles. These passed directly back to five-eighths-inch by eight-foot guy-rods cemented into the rock. Each strand was broken into at each end on the span side with a Brooklyn giant strand. The line wires were brought to the glass insulators of the lower cross-arm, looped around the strain insulator and soldered to the steel strand. Each pole was back-guyed with one-half-inch strand to guy-rods cemented into the rocks. Where long spans were required on line with wooden poles, the same construction was adopted, except that the poles were gained and the cross-arms lagged on.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), November.*

Earthed and Unearthed Radiators in Wireless Telegraphy.

In the early days of Hertzian space telegraphy, the solution of the signal problem was expected in the employment of straight beams of electrical radiation, hence it was that radiation of short wave-length, generated at the focus of a parabolic mirror, was the vogue among the wireless experimenters of that day. In an endeavor to get a larger output of radiation during each spark, Marconi, in 1895, connected large insulated conductors to one side of his oscillator, and contrary, perhaps, to what he expected, signals were found to be better when these insulated conductors were elevated to a distance from the earth, and better still when the far side of the spark-gap was earthed. This arrangement reduced the capacity of the system, and, in fact, capacity in itself seemed to be of so little account that the large elevated conductor could be removed and the connecting wire left supported alone in the air without greatly diminishing the strength of signals. Thus Marconi was led to the use of the plain earthed air wire, and to this much of his remarkable success must be attributed. The earthed air wire has, however, some disadvantages, and in this article Dr. W. H. Eccles discusses the value of the earthed conductor as compared with an insulated one. The merits of the earthed conductor are these: its great length ensures slow vibrations, and therefore long waves; it sets the waves up so that the electric force in the wave front is, from the very beginning, in a vertical plane; it attaches the free ends of the moving lines of force to the surface of the earth; and, lastly, it is a good radiator and absorber. Long waves are advantageous for reasons connected with diffraction. The setting vertically of the electric force near the earth avoids losses which would otherwise occur, and the attachment of the waves to the earth's surface prevents them straying wholly into space. But the air wire's power as a good radiator has become in this era of syntonic ambition its chiefest fault, for rapid radiation shortens enormously the train of effective waves if the energy stored electrostatically be small. At an early stage in his work, Lodge perceived this inadequacy of the simple air wire for syntonic working, and as early as 1897 was using, in preference, a symmetrical Hertzian wave-maker. Such a radiator fails to attach the waves to the earth's surface, but the freedom from earth connection eliminates the variability of this connection, and when a syntonic system is sought, tuning with a variable earth connection is difficult. Although the waves set up are free, later they attach themselves to the earth, but in so doing lose a part of their energy. The case stands thus: with the earthed wire we have an efficient radiator, but one which is not easily tuned, and from which it is difficult to maintain a sustained train of waves. With the insulated radiator tuning is not so difficult, and long trains of waves may be sent out, but these suffer a large loss in attaching themselves to the ground.—*Abstracted from the Electrician (London), October 27.*

The Design and Construction of Steam Turbines.

This is the first of a series of articles by Mr. Frank Foster, who purposes in them to discuss, in a practical and understandable manner, the merits of steam turbines and the proper methods of design and construction. While thermal efficiency is important, the true value of the device depends upon its commercial efficiency, and in an endeavor to improve it in the former regard, the designer may be carried too far. This point is illustrated in connection with condenser arrangements for a turbine. The higher the vacuum, the lower the steam consumption of the turbine, yet sometimes turbines are operated with costly condensers at high vacua, although they would be more efficient commercially without a condenser. All turbines, whether using steam or other fluid, derive their power from changes in motion of the working fluid. The driving force is never the static pressure. The pressure in a steam turbine might be infinite, but unless the steam possessed the requisite ve-

locity, the turbine would not act. On the other hand, if the steam possessed the necessary velocity, the pressure might be zero, and yet the turbine would work quite normally. To illustrate this point, assume a vertical turbine immersed in water or mercury. The pressure on the lower blades will be greater than that on the upper, and yet, of course, the machine will not rotate of itself. It is sometimes said that the fall of pressure toward the exhaust end of a Parsons turbine produces end thrust and assists the rotation, yet the illustration quoted above shows this not to be true. Indirectly, the fall in pressure in a steam turbine does produce both end thrust and rotation, but the fall in pressure generates velocity in the steam, and this velocity causes the turbine to rotate, and where the blades are not symmetrical end thrust results. There are but two classes of turbines—the action and the reaction. The action turbines are those in which steam is expanded in a nozzle, thus acquiring velocity, and is then directed against the blades of the turbine. In the reaction turbines the steam is expanded as it passes through the moving blades. This classification is not strictly correct, since all turbines work by reaction. The energy of the steam must always be converted into kinetic energy before being transmitted to the turbine. The only difference is that in turbines of the Parsons type this conversion and transmission is going on continuously. It would be possible to design a turbine so that the whole of the kinetic energy would be generated in the moving blades, which would also absorb it.—*Abstracted from the Mechanical Engineer (London), October 28.*

Dimorphous Distribution of Electrical Energy.

An ingenious composite system of distribution has been devised by M. Brüll, who here describes it and points out its peculiar advantages. The system depends upon the physical law that if the electromotive forces of n phases of an alternating-polyphase flux, not sinusoidal, are added together algebraically, the result will be an alternating flux with a frequency n times that of the fundamental, provided, of course, this harmonic be present. This is easily shown by a consideration of the Fourier series, for by adding together the different terms of such a series, all values disappear, except that of the nth harmonic. To make use of this relation in practice it is only necessary to connect the neutral points of a polyphase system together by means of a wire, and the current flowing over this wire will be that due to the nth component of the electromotive force. The main system may then be used for transmitting polyphase currents, to be employed in the ordinary manner, while the outgoing polyphase lines form one conductor of a single-phase system, the other conductor being the wire between the neutral points, as just described. If it be not desirable to run a wire between the neutral points, the single-phase current may be returned through the ground. These two systems can be operated practically independently of each other. The polyphase currents may be distributed for power loads, and the single-phase currents for lighting, and variations in load on one system will not affect the regulation of the other. Where step-up transformers are employed, the single-phase system may be obtained by means of a three-phase transformer, the primary of which is connected to the polyphase lines in the usual way, and the secondaries connected in series in the proper manner. A distinct advantage of this system is the higher frequency existing in the single-phase circuits. Thus a low frequency may be employed for power distribution, and assuming the system to be three-phase, the frequency in the single-phase lighting circuit will be three times that of the polyphase system, adapting the former to illumination purposes. The necessary harmonic may be introduced into the system by a proper distribution of the flux of the main generator, but it will in general be more desirable to introduce it by means of a separate machine since in this way the ratio between the fundamental wave and the harmonic will not be affected by changes in load. Moreover, when two independent machines are employed, the voltages of the two systems may be entirely independent, except as limited by the requirements of insulation. This system does away with substations containing moving machinery. It transmits low-frequency polyphase currents for power purposes, and high-frequency single-phase currents for lighting purposes, using no other secondary apparatus than the ordinary types of transformer.—*Translated and abstracted from L'Industrie Electrique (Paris), October 25.*

Regenerative Control of Electric Tram Cars.

The value of regenerative methods of operating electric cars—that is to say, methods which return part of the kinetic energy of the car, which in the common systems is lost, to the line—is here discussed. It is thought that the hesitancy with which this system is being received is due largely to the inertia of operating railway men, who are satisfied to use the system most universally adopted by others, and who do not venture to improve matters by adopting what they believe to be an untried system. The regenerative system might be adopted without in any way interfering with the normal operation of the road, since it requires no change in the supply system. Cars could be retired one by one, the series field windings on the motors removed and replaced by shunt windings, the controller adapted to the new system, and the car returned. One disadvantage urged against the regenerative system is that it may cause serious sparking of the motors, but this is said not to be true; in fact, the conditions of commutation should be better, because with a shunt winding there must be a slightly increased counter-electromotive force developed in the motor armature, and hence there must be a stronger magnetic field. The saving effected by this system appears to be from fifteen per cent on level lines, to thirty per cent on hilly routes, as measured by wattmeters on the cars. This saving, if applied to such a system as that of the Salford (England) corporation, would amount to nearly 1.4 per cent on the whole capital outlay; but this is not the whole saving, since the diminished output required of the stations diminishes the line losses, and as the load on the stations would be less variable, the station would operate more efficiently. It is claimed, further, that there is less wear and tear on the cars, resulting in a saving in repairs. The system also allows the cars to be run efficiently at varying speeds. No fewer than twenty-eight cars have been operating by the regenerative system on the Birmingham (England) tramways for three months, and it is said that the officers of the system are fully satisfied as to its merits.—*Abstracted from the Electrical Review (London), October 27.*

Acetylene in Greece.

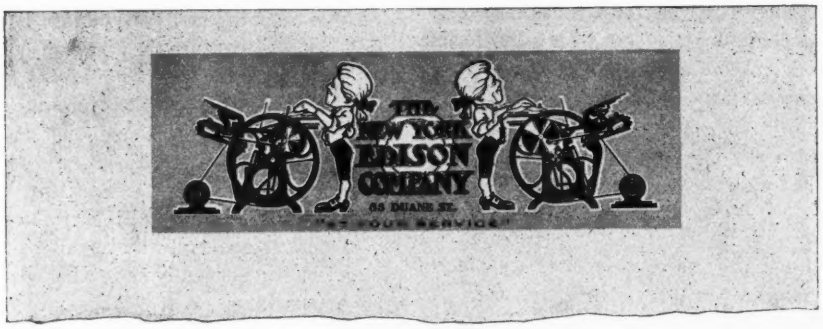
United States Consul Horton, of Athens, reports that several of the Greek cities have issued franchises to a company to supply them with acetylene for lighting. The rate to be paid is 0.68 cent per hour for each twenty-two-candle-power light. The rate to private consumers is to be one cent.

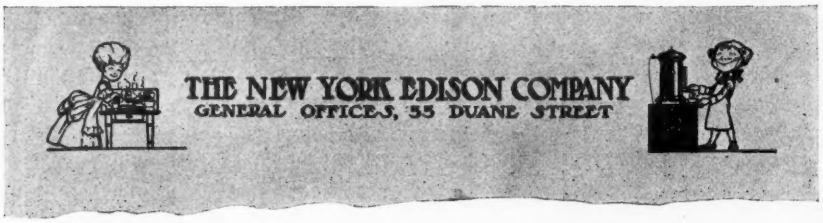
Three cities have already granted charters. They are Nauplia, Levkas and Arta, and work has begun in the first two mentioned. The general means of lighting cities in Greece is oil lamps.

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

In the planning of an advertising campaign, whether it be in the form of newspaper advertising, the distribution of booklets, blotters, striking folders, or advertising letters, too much attention can not be given to the various classes of people to which the advertising literature is to be directed. More than any one else, the advertising manager must put himself in the place of those at whom he directs his shots. He must have a keener idea of what comprises the psychological moment than possibly any other man in any other business. Advertising letters should be mailed to reach people when it is calculated they will have the best opportunity of giving them the proper attention. There are days in the week, varying, of course, with the business of the party addressed, when an advertising letter will be thrown to one side and neglected. There are other days when the busy housekeeper could not attend to an advertising letter and these various moods and opportunities must be studied and taken into account in developing the plan of attack. The New York Edison Company has hit upon a method of indirectly assuring its patrons that a real personal interest is being taken in the correspondence. Letterheads of various forms have been devised, and these are so arranged that if an enquiry is sent into the contract department or other department, relating to some specific use of electrical current, the return correspondence is carried on upon letter paper and under an illuminated head-piece which indicates that a special department is waiting to take care of the new business. Three of these letterheads are reproduced herewith. In one case there is a letterhead applicable for an enquiry concerning the use of current in a hotel or restaurant; in another, the use of current for power; and in the third, the use of current for domestic purposes. It has been the experience of the companies which have endeavored to lend emphasis to the matter of assuring the consumer of a personal interest, that nothing is so forceful in breeding confidence and in ultimately securing a customer.





Quite a number of the smaller central stations throughout the country are making a bid for the popularization of electric service through the use of syndicated booklets. These booklets are made up in a number of attractive styles, and call attention to the various uses of current. Electric chafing-dishes, laundry irons, water-heaters, advertising and decorative signs, power motors, and various forms of house lighting, are advertised and discussed. An illustration is given herewith of one of these syndicated booklets got out for a number of central stations by Reid & Rae, of Detroit, Mich.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A Practical Electric Hoist.

The accompanying illustration shows a two-ton electric hoist built by the Yale & Towne Manufacturing Company, New York city. This consists of a motor, controller and hoisting-gear balanced on a single-top hook, so that the centre of gravity does not change with or without load. The suspension is all taken on the hooks and two steel frame-plates, so that no cast iron is in tension. The top and bottom hooks swivel, and are equipped with ball-bearings. The single-top hook also admits of a flexible connection between hoist and trolley or other overhead support, to prevent side strains when the hoist is lifting out a true vertical line. This top hook facilitates using the hoist on short erecting jobs, or enables it to be attached permanently to an eye-bolt or overhead trolley. Installation involves simply

TWO-TON ELECTRIC HOIST, BUILT BY THE YALE & TOWNE MANUFACTURING COMPANY.

hanking the hoist and connecting two wires.

The power is transmitted through a bevel-gear and pinion (with cut teeth) to a worm and worm-wheel, which run in a bath of oil. The thrust is taken up by collars on the worm-shaft running in oil. All working parts are enclosed as protection against rain, dust or extreme heat. The hoist is equipped with a positive mechanical brake in addition to the load-sustaining gear. All machines are thoroughly tested for defects in material and workmanship before leaving the factory. The insulation must stand a breakdown test of 2,200 volts, alternating, from a transformer of adequate size. They are made to gauge, thus securing complete interchangeability. The gearing, motor, controller and other vital parts are easily accessible, facilitating adjustment or renewal of parts without completely dismantling the hoist or requiring it to be sent back to the factory. The rugged simplicity of the hoist enables its use in the hands of inexperienced workmen. No skilled electrician or operator is required.

The motor is of an accepted substantial design for severe hoisting work. The armature is of the "iron-clad" type, and designed to secure sparkless commutation at all loads within the capacity of the hoist. The brush contact density is computed on a liberal basis.

The controller is of the rheostatic type, and is designed especially for the severe service which arises in intermittent hoisting usage. It may be operated by pendant cords or telescopic rod. An automatic limit switch is provided which prevents the overtravel of the load in hoisting. All bearings are of bronze, and where not of the self-lubricating type, are fitted with self-feeding grease-cups, so arranged as to prevent oil entering the motor.

This hoist is regularly built in one, two, four and six tons capacity; other sizes to order. The height of lift is governed by the winding capacity of the drums, and is forty-five feet as a maximum for the two-ton size. Safety, material and workmanship have not been sacrificed to secure cheapness in price.

Yale & Towne electric hoists are in use in many large works throughout the country, a few of which are given as follows: machine shops, structural shops, locomotive works, foundries, bridge works, smelting and refining works, street railway shops, railroad repair shops, ship yards, United States navy yards, pump and hydraulic works, car works, iron and steel works, sheet and tube works, boiler shops, power plants, rubber works, electric light plants, safe and lock works, building and construction, warehouses and erecting shops.

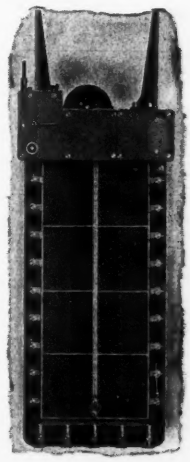
New Fan Motors for 1906.

The Westinghouse Electric and Manufacturing Company will have a new line of ceiling and floor column fan motors on the market the coming season, both direct and alternating current. These fans will have four blades and ball bearings, and will be finished in black enamel and oxidized copper. The alternating-current fans will be of the induction type and the direct-current fans will be furnished with three-point switches.

The regular line of alternating and direct-current desk and wall bracket fans will be as complete as requirements demand, and the current consumption, it is said, will be low for fans of these types.

Vertical "Long-Arm" Door for Closing Bulkheads on Battleships.

The "Long-Arm" System Company, Cleveland, Ohio, announces that the bureau of construction and repair of the United States navy department, after severe tests, has approved the new model C electrically operated bulkhead door



VERTICAL "LONG-ARM" DOOR FOR CLOSING BULKHEADS ON BATTLESHIPS.

made by the company. The ships for which this door was specifically approved are the Montana and North Carolina. The tests demonstrated that the door was fully capable of closing through coal, and its watertight qualities were demonstrated under high pressure. The nominal leakage of the doors under this pressure was so small as to give entire satisfaction to the representatives of the bureau who witnessed the tests.

In the course of the evolution of the "Long-Arm" system power doors, some minor defects developed in the first models. These defects have been overcome in the model C door, which is more direct in its operation, simpler in design, and, therefore, easier to keep in good condition than were the earlier models.

A New Line of Belt-Driven Alternators.

The requirements of modern generators are more severe than those of some years ago, due to the inductive load they must carry. To meet these requirements, a new line of belt-driven generators has been brought out by the National Electric Company, Milwaukee, Wis., the construction of which is shown in the accompanying illustrations.

These generators are manufactured in two types, which are termed the "R. B." type and the "R. C." type, respectively. In the former type the bearings are supported on a cast subbase, as shown in Fig. 1. In the latter the bearings are supported from the stationary armature frame itself.

These generators are of the revolving-field type. The frame of these machines consists of a circular cast-iron housing, in which the laminated punchings are assembled. This frame is shown in Fig. 2, where the inwardly projecting armature-teeth are clearly seen. Large open spaces are provided in the sides of the frames for free ventilation. The bases of all "R. B." type alternators operating at speeds less than 900 revolutions per minute are of such size and so constructed that the stationary armature can be moved in a direction parallel to the shaft, thus uncovering both the field and armature windings.

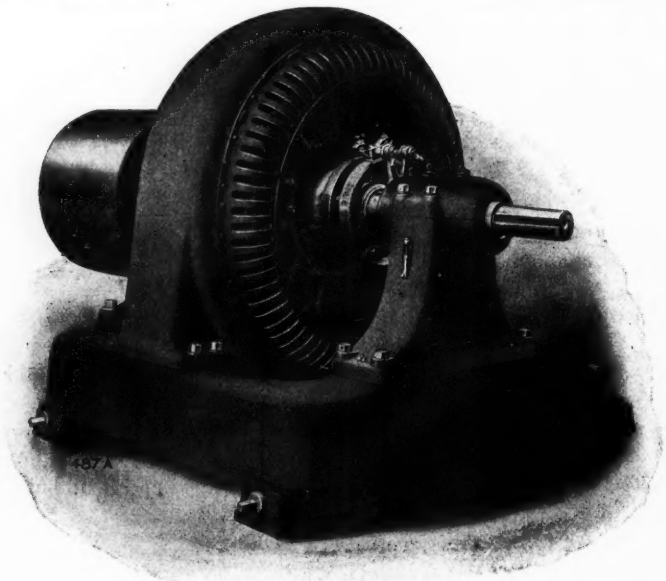


FIG. 1.—BELT-DRIVEN ALTERNATOR, MOUNTED UPON CAST SUBBASE.

FIG. 2.—FRAME OF REVOLVING FIELD, BELT-DRIVEN ALTERNATOR.

FIG. 4.—PORTION OF ARMATURE WITH COILS IN PLACE.

The armature core is built up of soft steel punchings, which are treated to reduce hysteresis and japanned before assembly. Special attention has been given to the shape and size of the slots, so as to produce, as nearly as possible, a sine wave electromotive force. The armatures are usually designed with six slots per pole, so that they may be wound for single, two or three-phase currents.

The armature winding consists of wire or strap-wound coils, depending upon the rating of the generator. Fig. 3 shows one of these coils after winding, and Fig. 4 the appearance of the coils as arranged in the armature. With alternators of high voltage and low current, wire coils are used, but where a large current output is required, the strap winding is employed. Each coil is form-wound in the proper shape, and well insulated before being placed in the slots. This insulation is applied in overlapping layers, and is wrapped with linen tape. The completed coils are dipped in a bath of special insulating compound and baked in a drying oven until all traces of moisture are removed.

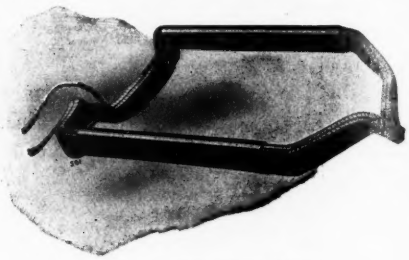


FIG. 3.—ARMATURE COIL.

The slots are lined with sheets of insulating material, within which the coils are placed. The end windings of the coil are arranged so that air can circulate freely among them, and thus maintain a low temperature. In case of injury from lightning, one coil only will probably be affected, and it can be easily lifted out and repaired or replaced by a new coil.

The field spider is constructed of cast iron or cast steel, as the speed conditions require. It is amply designed to withstand strains put upon it. The poles are laminated either wholly or in part, as determined by the size and operating conditions, and are bolted to the rim of the spider. A large factor of safety is allowed in the rotating part.

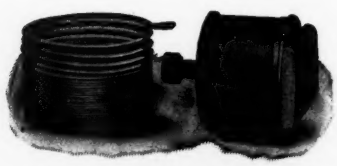


FIG. 5.—FIELD COIL WINDING.

The field coils are constructed of rectangular copper strap bent on edge, the

different turns being insulated from each other by layers of fibre paper, leaving the outer edge of every turn of the copper exposed to the air for cooling. Fig. 5 shows the character of this winding, and also the appearance of the coil as placed upon the pole. The pole-piece is surrounded by an insulating sleeve, over which the field coils are slipped. The coils are insulated from the spider and the pole by heavy fibre rings.

Fig. 6 shows the type of collecting-brush used on these machines. The brush-

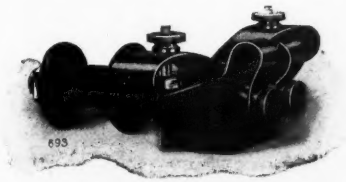


FIG. 6.—COLLECTOR BRUSH.

holder studs are of rod brass, and are supported from two arms cast upon the inner side of the bearing-cap. The brush-holders are of cast brass. Brush tension is maintained by a duplicate brass spring. Two brushes per collector ring are usually employed.

The collector rings are made of cast iron. The form of these rings is shown in Fig. 7. They are supported on a cast-iron spider, which is keyed directly to the shaft, and thoroughly insulated from the spider by fibre bushings and washers.

In designing the mechanical parts of

FIG. 7.—COLLECTOR RINGS.

these alternators, liberal proportions have been adopted. The bearings are of the self-oiling and self-aligning type. The base is provided with slide rails and belt-tighteners. The shafts are of forged steel, amply large, and the pulleys furnished are usually of paper or composition.

For small alternators a field rheostat is supplied with each exciter. For large machines an additional series rheostat may be supplied if desired.

The standard rating of the belt-driven alternators varies from thirty-seven and one-half kilowatts to 750 kilowatts. The standard machines are wound for voltages of 220, 440, 1,100 and 2,200. They can, however, be wound for voltages up to 15,000 if desired. The standard frequencies adopted are sixty and twenty-five cycles per second.

The maker guarantees the following performance: with full load, at 100 per cent power-factor, the temperature rise will not exceed thirty-five degrees centigrade in the armature and field. With a twenty-five per cent current overload, operating continuously at the same power-factor, the rise in temperature will not exceed forty degrees. With a fifty per cent overload it will not exceed forty-five degrees.

These machines are designed to give excellent regulation, the guarantee being that with non-inductive load the voltage will vary not more than sixty-seven per cent, and not more than sixteen to eighteen per cent with a power-factor of eighty.

A New Galvanometer.

The portable moving coil galvanometer described below has been patented by the Leeds & Northrup Company, of Philadelphia. The distinguishing feature of this instrument is the method of winding and suspending the moving system. Fig. 1 shows the general appearance of this galvanometer.

The suspension consists of upper and lower filaments, and in this particular it differs from the pivot and jewel as ordinarily used in instruments of the portable type. These filaments are protected against breakage in a manner to be described later. This arrangement of the filament suspension permits of high sensibility and avoids the initial friction to be overcome when jewel bearings are adopted as a means of suspension, a feature of especial importance when the galvanometer is used for zero methods. By reason of this fact the maker states that the instrument can be substituted for those of the mirror type in potentiometer work for accuracies of one-fifth per cent and in all Wheatstone and slide-wire bridge measurements for commercial accuracies. Its high sensibility makes it available for use in many cases where it was ordinarily supposed that it is necessary to use a non-portable suspended coil galvanometer. The entire construction of the instrument is one of extreme simplicity and compactness, and at the same time gives a sensitiveness and general efficiency which it has generally been considered impracticable to obtain in a portable type of galvanometer.

The magnetic field of the instrument is produced by a U-shaped cast-iron permanent magnet, shown in Fig. 2, having inwardly directed poles at one end so as to have north polarity only on one side of the air-gap separating the poles, and south polarity only on the other side. The magnet is slotted so as to accommodate the moving system, as shown. The air-gap between the poles is short, so that the field is uniform and intense.

The moving system consists of four flat coils of very fine wire wound alternately in opposite directions, so as to produce alternate north and south poles when viewed from one side, as shown in diagram in Fig. 3. These coils are held between two aluminum discs *b*, and sus-

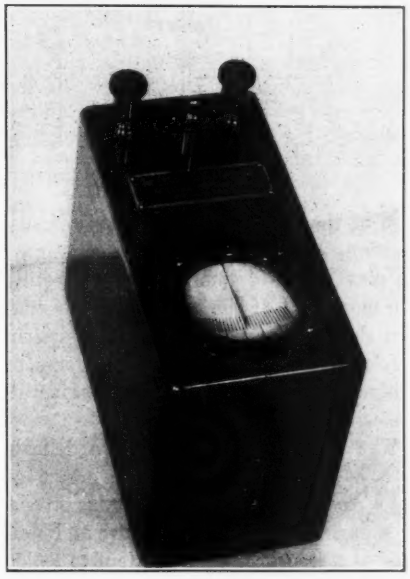


FIG. 1.—GENERAL VIEW OF NEW GALVANOMETER.

pended in such manner that normally only a portion of each coil extends into the air-gap between the magnet poles. At no time is more than about one-half of the coil surface between the pole-faces. When current is passed through the coils two of them of like polarity will swing around to enclose the greatest possible number of lines of force, while the other two coils will be repelled. The aluminum discs also serve the purpose of damping the system and rendering it dead-beat. The galvanometer can be given a high, medium or low resistance by connecting the coils in series, series-parallel or parallel.

The suspensions consist of three-wire filaments of a high tensile strength, of non-corrosive metal. To give the entire

system resiliency in the event of sudden jars, the upper suspension terminates in a spiral spring *c* (Fig. 2), and the lower suspension is attached to a long flat phosphor-bronze spring *d*, as shown in Fig. 2. An additional protection against excessive strains on the moving system is provided by means of two guards E, shown in Fig. 2. These guards have clearance holes to provide for the rotation of the system around its axis of suspension, but limit the sidewise movement or play of the system, thereby arresting the movement of the coil due to any sudden shock. The movement of the system vertically is limited by the pole-faces of the magnet, which prevents breaking of the wire filaments.

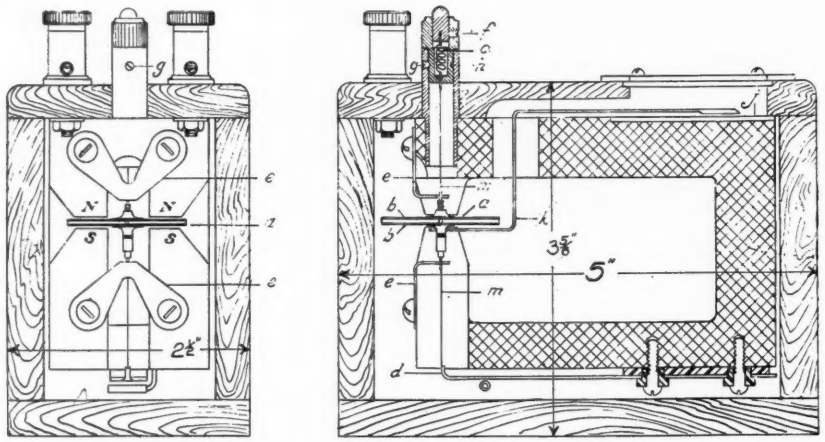


FIG. 2.—ARRANGEMENT OF PARTS OF NEW GALVANOMETER.

The torsion head *f* provides a delicate zero adjustment and also by means of the screw *g* operating in an annular groove, *h*, engages the end of the groove and thus acts as a stop to limit the extent to which the torsion-head may be turned, and thus prevents the suspension filament from being twisted off.

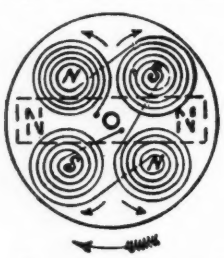


FIG. 3.—DIAGRAM OF MOVING SYSTEM.

The magnet, with its complete moving system and scale, is mounted in a highly polished mahogany case. A circular opening in the top, protected by a glass window, allows the scale to be seen. The binding-posts are securely mounted and are arranged to clamp large or small wires. The outside dimensions of the case are five inches by two and one-half inches by three and one-half inches high.

Reissue of an Important Edison Lamp Patent.

Edison patent No. 444,530, which was one of the patents relied upon in the agreement among licensees, covers the use of two metals in the seal of the incandescent electric lamp, one having the coefficient of expansion of glass, such as platinum, and the other having a different coefficient, and being, therefore, possibly a cheaper metal. The claim covers the making of the seal over the joint between these two metals, and thereby rendering it unnecessary to have the quantity of platinum otherwise necessary to go all the way through the seal. Various suits have been pending on this patent; the defendants claim that this principle of the two metals in the seal was used in the old Heisler lamps and in the old Bernstein lamps before the Edison patent was applied for. Recently the plaintiff's attorneys surrendered the original patent and asked to have it reissued upon a showing that the claims were too broad. This terminates all pending suits on the original patent, that patent having been declared invalid and inoperative by the complainant under oath in the application for reissue. It is presumed in lamp circles that new suits will be instituted upon the reissued patent.

In the suits against the Germania Electric Lamp Company, of Harrison, N. J., it is claimed that no such suit on the reissued patent can be brought for the reason that when the original suit was started Mr. George Campbell, of that company, stopped using the two metals in the seal, as he found it made only an eighth of a cent difference per lamp to entirely avoid any shadow of infringement, and he has not used the two metals inside the seal since the reissue.

As to the old suits an interesting question has arisen as to the terms upon which they may be dismissed. Messrs. Dyer & Dyer, attorneys for the Edison Electric Light Company, which is the corporation having the legal title to this particular patent, have asked the defendants to consent to the dismissal of the suits without prejudice, on payment of the usual legal costs. Mr. Campbell's attorneys refused to consent to this and insist that under the peculiar circumstances the courts should allow the defendants their counsel fees and their legal expenses, and also make an order to the effect that the testimony heretofore taken by defendants may be used in any new suit which may be brought upon the reissued patent. It is understood that no reply to this proposition has been made and the matter is still unsettled. If the parties do not agree, the whole question will probably be submitted to the United States Circuit Court in New Jersey for decision.

New Atwater Kent Meter.

The accompanying illustration shows the new automatic pocket volt-ammeter which has recently been placed upon the market by the Atwater Kent Manufacturing Works, 42 North Sixth street, Philadelphia, Pa. This meter is of the dead-beat type, the needle coming to rest quickly, thus making rapid and accurate reading possible. It is adapted to any work where primary batteries are used. The maker guarantees it to be accurate, as it is hand-calibrated by means of standardized apparatus, besides being thoroughly tested. The meter is furnished in a neat hand-sewn leathern case. These volt-ammeters are made in two styles: from zero to five volts, and zero to twenty amperes; and from zero to ten volts, and zero to twenty amperes.

The company also makes ammeters and voltmeters in separate cases. The general appearance of these instruments is the same as that of the automatic volt-ammeter. The voltmeters, however, have no button attachment, but have the dead-beat feature. They are made in two styles: from zero to six volts, and zero to ten volts. The ammeters are made in three sizes: zero to ten, zero to twenty-five, and zero to thirty amperes. Meters with special readings up to thirty amperes and thirty volts are made to order. These meters have been found very convenient in making battery tests.

NEW PORTABLE VOLT-AMMETER.

A New Electrically Controlled Oil Switch.

A new type of electrically controlled oil switch, made by the Hartman Cir-

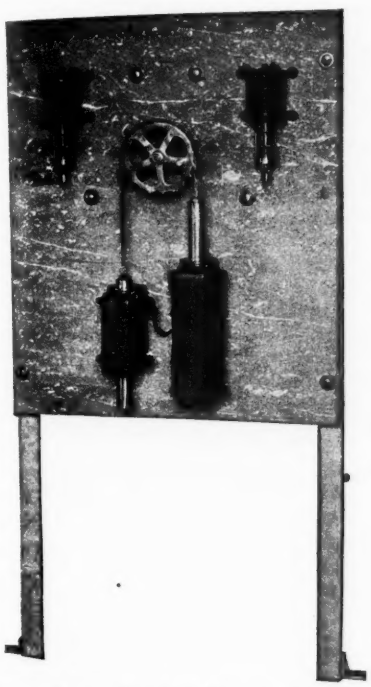


FIG. 1.—FRONT VIEW OF PANEL, WITH ELECTRICALLY CONTROLLED OIL SWITCH.

cuit Breaker Company, Mansfield, Ohio, is shown in the accompanying illustrations. This circuit-breaker has been de-

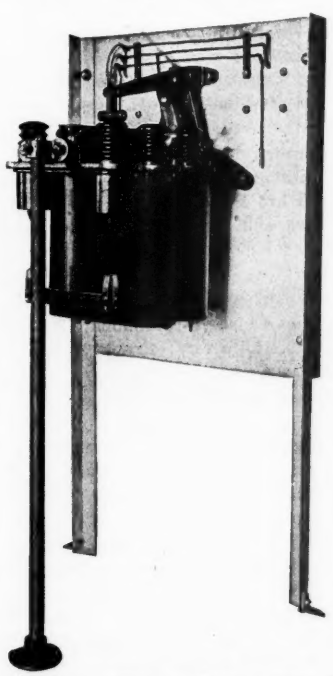


FIG. 2.—REAR VIEW OF PANEL, WITH ELECTRICALLY CONTROLLED OIL SWITCH.

vised to meet the growing demand for remotely controlled switches—that is to say, switches placed at one point and controlled by a small secondary switch at the main operating board.

Fig. 1 shows a front view of the panel upon which the circuit-breaker is mounted. This panel may be placed at any point in the station where it is convenient. The circuit-breaker proper is mounted in the back of the panel, as is shown in Fig. 2. It is operated by the rotation of the sprocket wheel on the panel by means of the chain geared to it, which chain itself is drawn in one direction or the other by means of one of the two solenoids mounted on the front of the panel. The larger solenoid closes the switch by drawing down its core, and vice versa, the switch is opened by a similar action of the solenoid shown on the left. Current for operating the two solenoids is generally supplied from the exciter circuit. The solenoids are supplied for any standard voltage.

This circuit-breaker can be supplied in an automatic type by the addition of an overload and time-limit relay. The time-limiting action is obtained by means of a piston moving in a cylinder. Air is admitted to the cylinder through a small opening, which can be varied, thus regulating the time required to operate the relay, as may be desired. This time can be anything under ten seconds. The relay acts more quickly the heavier the load, and on a very heavy overload will act almost instantaneously.

The particular switch shown in these illustrations is the standard three-pole type C, which is made for potentials up to 22,000 volts. All live parts of the switch are enclosed, and the containing-cell, which is made of a specially treated fibre, is so shaped as to keep separate the various breaking points. The contacts in this switch are of the laminated double-break type.

The Electrical Equipment of the New York, New Haven & Hartford Railroad.

It will be remembered that the New York, New Haven & Hartford Railroad announced, some time ago, that it had decided to adopt the alternating-current system, and operate its road by means of electric locomotives, while the New York Central & Hudson River Railroad, over whose tracks the New Haven road reaches the Grand Central station, will use the direct-current system. The following statement has been prepared by Mr. William S. Murray, electrical engineer for the New Haven road, respecting the equipment selected by that company for its New York division:

Concerning the proposed method of electrification, it is interesting to note the unsolicited and general concordance of opinion on the part of certain engineers, and gratifying in the main to note a temerity in expressing a concrete opinion of our decision.

Without a full appreciation of the relevant factors in the case one could hardly view with a more kindly eye a hearty endorsement of our conclusion than a condemnation of it. Certainly the first indication of a real engineer is his reservation of an opinion until all these relevant factors have, in the full knowledge of their true bearing, been assembled. Today a conclusion is worth nothing that is not a compromise. A compromise is the true algebraic sum of all the relevant factors.

After six months' careful study of the possible methods of electrification a conclusion has been reached. The work has been too initiative, the ground too new and the opportunity too exceptional not to have kept an accurate log upon the method of procedure. Were it possible to devote time to things other than an expeditious and careful continuance of the work begun, we would gladly segregate this conclusion into its relevant factors and discuss it with those engineers who by the reservation of their concrete opinion have shown a silent wish to later agree or disagree with its plan.

To the two great electrical manufacturing companies which have placed the genius of their engineering in our hands for consideration, we have nothing but the highest tribute to pay. It has been no mean privilege to make a minute study of their individual viewpoint of the problem. It is true their analysis of the situation has dictated widely separated conclusions, and those engineers who appreciate the trust imposed in this decision for the New Haven road can readily understand that the divergence of opinion has served only to double the responsibility of the conclusion, but by which the engineers for the New Haven road are in no way disturbed.

To those minds prone to a conclusion without the assistance of the relevant factors, it may be a helping thought to say that throughout the study of the New Haven's electrification the Central's plans have been a constant and most relevant factor. The conditions of the New Haven problem, however, are widely different. It has been deemed that alternating current is pertinent to their proper fulfilment. Because the New Haven locomotives will be operative either on direct or alternating current, in no way emphasizes the importance of their interchangeability. The condition imposed, in effect, makes valuable the double characteristic. A criticism of the Central's plans is irrelevant and unnecessary; direct-current propulsion is the judgment of their engineers. Our concern is its effect upon us, and it is read in the direct characteristic of our locomotive.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

MERGING OF TELEPHONE COMPANIES—With the Charleston Home Telephone Company as a foundation an effort will be made to consolidate all of the independent telephone companies of West Virginia. Considerable Ohio capital will be interested in the project. Several meetings of the promoters have been held at Charleston recently. Among others interested in the movement are Governor W. M. O. Dawson, State Auditor Sheer, Tax Commissioner Dillon, Henry G. Davis and S. B. Elkins, of West Virginia; Frank L. Beam and Dwight G. Sapp, who are well known in the independent field, and prominently connected with the Columbus (Ohio) Citizens' Telephone Company.

NEW ELECTRIC ROAD SEVENTY-EIGHT MILES LONG—The Catskill Mountain & Mohawk Valley Railway Company has been incorporated with a capital of $2,000,000, to construct and operate an electric road seventy-eight miles long, in Greene, Delaware, Schoharie and Otsego counties. The line will extend from Cairo to Oneonta, with a spur from Jefferson, Schoharie County, to Stamford, Delaware County. The directors are E. C. White, Edgar B. Holbridge, Charles V. D. Peck, William B. Reed, Jr., and James W. McCabe, of New York city; Herbert S. Lounsbury, Port Chester; Marcus Hirchfield, Rochester; E. E. Billings, of Gilboa, and George W. Kendall, of Stamford.

CURRENT TRANSMITTED FROM LOCKPORT LINE—Electrical power for commercial purposes is being delivered over the transmission line from Devil's Hole to Lockport, N. Y. Connections with the power-house of the Lockport Gas and Electric Light Company were completed on the morning of November 5, and current was turned on at three o'clock the following afternoon. Twelve thousand volts is the present tension of the line, and until the construction work at the proposed power-house near Lockport and the transformer house at the Devil's Hole is completed this will be the voltage. When the construction work is completed 60,000 volts will be the tension on the line.

HOME TELEPHONE COMPANY ORGANIZED IN DETROIT, MICH.—At a meeting held on November 6, at Detroit, Mich., capitalists interested in the Home Telephone Company took initial steps in the matter of a permanent organization. Three Detroit capitalists and seven St. Louis men were chosen directors, as follows: C. M. Burton, W. W. Hannan and T. A. E. Weadock, Detroit; Henry Koehler, Jr., C. M. Forster, Hugo A. Koehler, A. W. Lambert, Herman C. Stifel, Samuel B. Jeffries and Max Koehler, St. Louis. It has been decided to increase the capital to $5,000,000. The Home Telephone Company is projected as an independent concern, and is negotiating for the purchase of the Cooperative Telephone Company, a small independent plant in Detroit, which has connections with other independent systems in the state.

MERGER OF LIGHT AND RAILWAY INTERESTS—Articles have been filed with the secretary of state increasing the capital stock of the East Liverpool Traction and Light Company from $6,000 to $3,000,000, as the result of a traction and light merger in southeastern Ohio. The deal includes the suspension bridge over the Ohio between East Liverpool and Chester, Pa., the East Liverpool & Rock Spring traction line, Rock Spring Park; the Chester Light and Power Company and the People's Light and Power Company. These properties will be merged with the electric lighting companies of East Liverpool and Wellsville. It is said that this move is a preliminary to a merger of all the electric lighting companies in eastern Ohio. Options have been taken on the Steubenville electric lines which extend to Toronto, and to Brilliant, and a gap is to be filled in between Toronto and Empire. Buffalo (N. Y.) capital is behind the movement.

MEXICAN ELECTRICAL NOTES—Authority has been granted to Canuto Reyes or the company he may organize to build the hydraulic works required to utilize 300 litres of water per second from the Atoyac river in the district of Galeana, state of Guerrero. Under the concession the surveys must commence within six months and the plants be presented to the department of works within twelve months. Construction must begin within two years, and be finished within seven years. The usual conditions and stipulations are defined in the concession, including the free importation of the necessary machinery and material. The concessionaire guarantees the proper fulfilment of his obligations by depositing the sum of $12,000 in bonds of the national debt in the National Bank. It has been announced that the necessary capital is forthcoming, and that contracts have been signed, for the commencement of the building of the proposed power plant for Parral, Mexico. The company is headed by Eugene Davis, and has secured a twenty-year concession from the Mexican government. The company holds the right to manufacture and sell power for mills and electric railways, and to treat, buy and sell ores. The initial power plant is to be installed in zona 10, in the extreme northwest corner of the state of Durango, about fifty-one miles from Parral, and will consist of 3,000 horse-power in six units of 500 horse-power each.

NEW INCORPORATIONS.

FRANKFORT, KY.—Pikeville Electric Light Company. $50,000.

BOSTON, MASS.—Ware & Brookfield Street Railway Company. $100,000.

NEW HAVEN, CT.—Southern New England Telephone Company. Increased to $10,000,000.

HOUSTON, TEX.—Texas-American Electric Light and Power Company. Increased from $40,000 to $80,000.

MILWAUKEE, WIS.—Kenosha Home Telephone Company. $75,000. Incorporators: Alonzo Burt, James Cavanagh and Frank Glasson.

ST. PAUL, MINN.—Glenwood Telephone Company, Glenwood. $12,000. Incorporators: M. A. Wollan, C. T. Wollan, C. O. Wollan, Peter Peterson, H. D. Peterson.

NASHVILLE, TENN.—The W. C. Cole Telephone Company, Decatur County. $3,000. Incorporators: W. C. Cole, J. U. Speer, L. A. Rains, L. H. Burke and Frank Kent.

SALT LAKE CITY, UTAH—Malad Light and Power Company. To succeed to the franchise, plant and rights of G. C. McLaughlin and Frank Moore in the town of Malad, Ida. $100,000. C. F. Little, president; D. S. Taggart, vice-president; G. H. Jay, treasurer; J. A. Largent, secretary.

BUFFALO, N. Y.—East Concord Telephone Company. To run a line through Concord, Sardinia and Colden. $5,000. Directors: J. L. Smith, Samuel D. Vance, Ward H. Marse and Fred T. May, of East Concord; George J. Domes and A. E. Spencer, of Sardinia, and L. A. Vaughn, of Concord.

INDIANAPOLIS, IND.—Northwestern Indiana Interurban and Street Railway Company. To construct and operate an electric line in and between the towns of East Chicago, Hammond, Crownpoint, Cedar Lake and Lowell. $10,000. Directors: Franklin L. Knight, Edwin Knight and Webster B. Ray.

MADISON, WIS.—The Milwaukee Northern Railroad Company. To build an interurban electric line from Sheboygan to Milwaukee, touching Fond du Lac, Port Washington and other places in that vicinity. $100,000. Incorporators: John E. Uselding, of Port Washington; John M. Saemann, of Sheboygan, and Peter P. Brueckbauer, of Elkhart.

CHARLOTTE, N. C.—High Point-Winston-Salem Interurban Electric Railway Company. To build and operate a line between High Point and Winston-Salem, and also local trolley lines. $450,000. Directors: John E. Reyburn, F. A. Chaplin, John P. Hardin, Philadelphia; C. P. Hancock, Danville, Pa.; C. C. Yetter, Bloomberg, Pa., and J. H. Mills, High Point. Mr. Mills is president.

BALDWINSVILLE, N. Y.—Plainville & Meridian Telephone Company. To operate between Plainville and Cato and extend through Lysander to Cato and Ira, Cayuga County. $1,700. Directors: George W. Simmons, George R. Calkins, Uriah Everts, Jr., James Heron, Elmer E. Carncross and Charles A. Pooler, of Cato; Lester Schenck and G. B. Smith, of Memphis, and Charles F. Davis, of Plainville.

PERSONAL MENTION.

MR. F. S. WALL has been appointed manager of the Aiken (S. C.) exchange of the Southern Bell Telephone Company.

MR. C. E. A. CARR has been appointed manager of the Helena Light and Railway Company, succeeding Mr. Howard S. Reynolds, who returns to New York.

MR. A. F. SHELDON, president of the Sheldon School of Scientific Salesmanship, lectured at the Edison Auditorium, 44 West Twenty-seventh street, New York city, on Thursday evening, November 2.

MR. C. E. STINSON, of the Toledo Home Telephone Company, has been appointed consulting engineer of the Indianapolis Telephone Company and the new Long-Distance Telephone Company, of Indiana, which have recently passed to the control of Toledo parties.

MR. T. C. MARTIN has been appointed editor of progress to report to the twenty-ninth convention of the National Electric Light Association next May or June. For the past three years Mr. Martin has made a comprehensive report on the progress made during each year in the various branches of the art in this country and abroad.

PROFESSOR WILHELM OSTWALD, who is in this country, and particularly at Harvard University, giving lectures upon chemistry, was the guest of honor at a reception and banquet under the auspices of the physical science department of the Brooklyn Institute of Arts and Sciences, at the Kings County Democratic Club, Saturday evening, November 11. Professor Irving W. Fay presided, and at his right and left sat Professor Ostwald and A. Augustus Healy, president of the institute. The others at the principal table were Professor William A. Noyes, Professor T. W. Richards, William H. Nichols, Professor E. W. Clarke, Professor Charles F. Chandler, Baron von de Bussche, H. W. Wiley, of the department of agriculture; Comptroller-Elect Herman A Metz, Consul C. Gneist, George von Skaal and the Rev. Dr. John W. Heischmann. A number of addresses were made by several of the distinguished guests present.

MR. A. P. PECK has joined the staff of the Allis-Chalmers Company, and will hereafter be connected with the New York office of that company. He will travel throughout the New York district, giving particular attention to the sale of the power and electrical machinery. Mr. Peck is well known throughout the Middle West as a salesman of electrical machinery. After graduating from Purdue University in 1892, with the degrees of B. M. E. and E. E., he became associated with the World's Columbian Exposition Company, and was connected with the electrical engineering department of the Chicago World's Fair until January, 1894, as assistant engineer of arc lighting. From 1894 to 1896 he was with the Westinghouse Electric and Manufacturing Company. It was under his supervision during this time that the motors and wiring were installed in the cars of the Chicago City Railway Company. Mr. Peck began his career as a salesman in 1896, and has since been connected with the New York Belting and Packing Company, the engineering department of the Chicago Edison Company, and as electrical sales agent with the National Electric Company.

EDUCATIONAL.

LECTURES AT THE UNIVERSITY OF MINNESOTA—Mr. E. P. Burch, consulting electrical engineer, is to deliver a course of four lectures on heavy electric railroad work before the senior engineers at the University of Minnesota. The subjects of the individual lectures are "The Physical and Financial Advantages of Electric Traction for Heavy Railway Work," "The Speed-Torque Characteristics of Steam Locomotives," "The Speed-Torque Characteristics of Electric Locomotives" and "The Physical Data for the Electrical Equipment for Operating a Division of a Trans-Continental Railway." These lectures, which supplement the regular class-room electric railway course, are based upon the investigations made by Mr. Burch for some of the western railway companies which are investigating the feasibility and desirability of electric traction upon certain divisions of their main lines.

ELECTRICAL SECURITIES.

Notwithstanding the expectation in many quarters that the pronounced boom of several weeks ago would be upheld, there was a rather sharp break in stock issues during the past week. This break has been laid to the fact that the monetary situation developed an extreme tightness, and left a good many interests without the possibility of continuing their efforts to hold up their high prices. Notwithstanding the break, those who have been favoring a bull market, and who have kept prices above by main strength, have in their favor the notable general and widespread industrial activity and prosperity. With but a little release in the money pressure there is hardly any doubt that booming conditions would immediately revive, and that a market of high security values would be the order of the day for some time to come.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 11.

New York:	*Closing.*
Brooklyn Rapid Transit	75⅞
Consolidated Gas	182¼
General Electric	185
Interborough Rapid Transit	207⅞
Kings County Electric	200
Manhattan Elevated	163½
Metropolitan Street Railway	116⅛
New York & New Jersey Telephone	150
Westinghouse Manufacturing Company	190

The stockholders of the Manhattan Railway Company at their annual meeting reelected the retiring directors. At a subsequent meeting of the board George J. Gould was reelected president; Alfred Skitt, vice-president, and B. W. McWilliams, secretary and treasurer.

Boston:	*Closing.*
American Telephone and Telegraph	135
Edison Electric Illuminating	247
Massachusetts Electric	55½
New England Telephone	134
Western Telephone and Telegraph preferred	89

The annual report of the Massachusetts Electric Companies for the year ended September 30 shows gross earnings of $6,665,529, an increase of $284,666 over 1904; net, $2,265,329, an increase of $363,986; surplus after charges, $738,458, an increase of $299,741. A syndicate headed by the Old Colony Trust Company has purchased a block of $3,500,000 4½ per cent five-year gold notes of the Massachusetts Electric Companies. These notes were authorized at the annual meeting last July and replace a like amount of notes, of which $2,700,000 was outstanding. Of the new issue $2,700,000 will be used to retire the $2,700,000 of notes now out and which mature January 1, and the remaining $800,000 notes will be issued and the money invested in the notes of the controlled corporations. These notes are secured by shares of the Boston & Northern and Old Colony Street Railway companies.

Philadelphia:	*Closing.*
Electric Company of America	11⅝
Electric Storage Battery common	80
Electric Storage Battery preferred	80
Philadelphia Electric	8½
Philadelphia Rapid Transit	27
United Gas Improvement	92

Chicago:	*Closing.*
Chicago Telephone	138
Chicago Edison Light	163
Metropolitan Elevated preferred	72
National Carbon common	63
National Carbon preferred	116⅞
Union Traction common	12½
Union Traction preferred	37

OBITUARY NOTICE.

MR. BEAUCHAMP H. SMITH, second vice-president of the S. Morgan Smith Company, York, Pa., died at his home in Los Angeles, on November 1, at the age of thirty-six years. Mr. Smith went to Los Angeles about five years ago for the benefit of his health, since which time he had resided there.

ELECTRIC LIGHTING.

BROCKPORT, N. Y.—Brockport is to have new street arc lights.

MENASHA, WIS.—Menasha has voted to install an electric light plant.

CLINTON, IOWA—Le Grande has voted to establish a municipal lighting plant.

NEWARK, N. J.—A contract has been let for a 250-horse-power engine for the electric light plant at Pleasantville.

LEBANON, PA.—The Edison Electric Illuminating Company will supply Myerstown and Avon with electric lights.

OYSTER BAY, N. Y.—The Nassau Light and Power Company has purchased the Oyster Bay Electric Light Company.

BELLINGHAM, WASH.—The Bellingham city council has ordered thirty-nine new arc lights for street lighting purposes.

LITTLE ROCK, ARK.—Spencer Owen has been granted a franchise for the establishment of an electric light plant at Springdale.

FLORENCE, COL.—The town of Rockvale has granted a twenty-five-year franchise to the Arkansas Valley Electric Light Company.

UTICA, N. Y.—The village of Lyon Falls has entered into a contract for a term of five years with G. H. P. Gould to furnish street lights.

FALCONER, PA.—E. W. Jordan, of the Corry Electric Lighting Company, has secured a five-year contract to light the streets of Falconer.

BELLEFONTAINE, OHIO—Appropriations have been made by the Bellefontaine council for a new municipal electric light plant to cost $50,000.

FOREST, OHIO—At a special meeting of the Forest town council it was decided to advertise for bids for the erection of an electric lighting plant.

NEWARK, N. J.—The Cape May electric light system is to be extended to Rio Grande, seven miles away, supplying light to the villages along the route.

AUBURN, NEB.—The Auburn city council has entered into a contract with the Auburn Mutual Lighting and Power Company to light the streets, lanes and alleys of the city for a period of five years.

BANGOR, ME.—The Greenville Light and Power Company is constructing a new and larger electric plant a short distance south of the outlet of Wilson pond, about three miles east of Greenville.

LOCKPORT, N. Y.—The Economy Light, Heat and Fuel Company, which recently obtained a franchise, will soon start work on its new electric light station. It is expected to have the plant in operation within six months.

GREEN BAY, WIS.—William Mainland, of Oshkosh, and Sinclair Mainland, of Green Bay, have closed a deal for the sale of the gas and electric lighting plant at Fargo, N. D., of which they were principal owners, to New York parties.

NORFOLK, VA.—J. Edward Cole and W. D. Pender, representing separate interests, have each offered to install an independent electric lighting and power plant in Norfolk if the retail merchants will subscribe to a certain amount of stock.

NEW LISKEARD, ONTARIO—D. S. Pindell has been granted a franchise for both electric light and water-works systems. The works are estimated to cost $102,000, and the town agrees to guarantee the company's bonds to the amount of $80,000.

WASHINGTON, N. J.—Harry Reed has sold the plant of the Washington Electric Light Company to A. B. Beadel, of New York, and O. R. Maxwell, of Easton. The sum realized was $24,800. Mr. Maxwell is interested in the Easton Electric Lighting Company.

BUENA VISTA, COL.—The Buena Vista Electric Light Company has leased its plant to W. P. Eyre, who for a number of years has had the management of the plant. He has already begun remodeling the works, having installed a 125-horse-power Leffel water-wheel. The old incandescent lights used by the city are to be replaced with twenty-one enclosed arcs.

ALBUQUERQUE, N. M.—The Gallup electric light plant, owned by Gregory Page, has been sold to E. C. Allen. The terms of the sale have not been made public, but it is learned that the consideration is about $25,000. It is also learned that the First National Bank is interested in the purchase.

POTSDAM, N. Y.—A statement has been issued by the Hannawa Falls Power Company to the effect that the power company has secured the permission of all property owners along the route of the proposed power transmission line from Hannawa Falls to Ogdensburg, and that the pole line will soon be completed.

PARKERSBURG, W. VA.—The Acme Electric Company has secured its charter of incorporation, and at a recent meeting it was formally organized. The officers elected are: president and general manager, Henry M. Moses; vice-president, Frank S. Mead; secretary, Richard K. Gibson; treasurer, Lewis P. Self; superintendent, Hugh J. Henry.

DULUTH, MINN.—Work has been started on the new distributing plant for the Great Northern Power Company. The contract, amounting to $100,000, was recently awarded to J. W. Hilliard, and the structure is to be completed by next May. It will be five stories high, with a frontage of seventy-two feet on Fifteenth avenue and 144 feet on Michigan and Superior streets.

WATKINS, N. Y.—The Watkins Consolidated Gas and Electric Light Company, which went into the hands of a receiver last spring, has been reincorporated and will hereafter be known as the Watkins Illuminating and Power Company. The incorporators and chief stockholders are M. L. Driesbach, of Philadelphia, and M. H. Horn, of Jersey City. The capital stock has been fixed at $50,000.

NEWARK, N. J.—A special committee has reported to the Newark board of works that an electric light plant could be established at a cost of $125,000, which would light the streets at about one-half the present cost. The board of works has asked the city council for an opinion on the city's right to build such a plant under present laws and will, if necessary, ask authorization from the state legislature.

MINNEAPOLIS, MINN.—The Stillwater Gas and Electric Light Company held its annual meeting recently. E. L. Hospes was reelected president; J. H. Brown, of Chicago, vice-president; J. G. W. Johnson, secretary and treasurer. The company decided to make a number of improvements next season, including the erection of a new building in which electricity will be generated when it is impossible to secure the desired current from the company's plant at Apple river.

LOS ANGELES, CAL.—The contract for the lighting of the public streets has been let by the council to the Los Angeles Gas and Electric Company for a term of three years. The cost will be $75.60 a year for each light. The same company is now supplying the city's lights at a cost of $6.75 a month for each light. During the next three years 300 lights will be added every year, which will make the total cost for lighting for the three years about $500,000.

PHOENIX, B. C.—W. M. Douall, president of the West Kootenay Power and Light Company, Limited, recently visited Phoenix, and viewed the extensions of the company's pole lines into the boundary now under construction. The president stated that the cost of the installation of the new machinery at Bonnington, on the Kootenay river, together with the pole lines, will be about $1,000,000. The company will have 28,000 horse-power for industrial purposes and expects that the lines into the boundary will be ready for transmission purposes in March or April.

JACKSON, MICH.—The Ceresco dam, being built by the Commonwealth Power Company, will be completed about December 15. Next to the dam at Allegan, owned by the same company, this dam will be the largest in the state, and will cost about $150,000. The power derived from it will supply several electric roads, as well as many cities and villages. The Commonwealth company has contracted to furnish power to operate the Jackson & Lansing electric road. When this line is completed, it is stated that the company will furnish power for the Lansing & St. Johns and Lansing-Haslett Park lines, in addition to supplying manufacturers with power.

ELECTRIC RAILWAYS.

ABERDEEN, WASH.—The extension of the electric railway from Aberdeen to Cosmopolis has been completed. Later the line will be extended to Montesano and Elma.

COLFAX, WASH.—The Spokane & Inland Electric Railroad Company has bought $40,000 worth of property in Colfax for terminals for its new line now being built from Spokane to Pullman.

FRANKLIN, PA.—A number of Titusville men are interested in a project to build a traction line from Pleasantville to Oil City. If built, the line will connect with the Citizens' Traction Company at Pleasantville.

AUSTIN, TEX.—It is announced that a syndicate of New York capitalists is interested in the building of an interurban electric line from Austin to Lockhart, and that a preliminary survey will be made at once.

ST. LOUIS, MO.—The Oklahoma City, Lexington & Sulphur Springs Electric Railway Company has broken ground for its extension to Norman from Oklahoma City. The road will be ready for operation June 1, 1906.

NEW HAVEN, CT.—The New York, New Haven & Hartford Railroad Company has purchased the Danbury & Norwalk Street Railway for $750,000. C. S. Mellen, president of the New York, New Haven & Hartford, has been chosen vice-president.

ROCHESTER, N. Y.—An order has been placed with the General Electric Company by the Rochester Railway Company for eighty motors for the equipment of the twenty cars now being built in Cleveland. The new cars will have four motors each. The cars are expected to arrive some time in December.

ATTLEBORO, MASS.—Attleboro is to be accommodated with a direct line to Providence if the present plans of the Taunton & Pawtucket Street Railway are carried out. The route is virtually an extension from Brigg's Corner to East Providence, a distance of six miles, and the running time from Attleboro would be fifty-three minutes.

GUTHRIE, OKLA.—The Tulsa city council has granted a franchise to Lyman L. Parker, of St. Louis; George E. Johnson, of Shreveport; C. W. Brown and others, of Tulsa, to build, equip and operate an electric railway system with suburban lines to the adjoining coal and gas fields. Mr. Parker is general solicitor of the Frisco system.

BROOKLYN, N. Y.—Steam passenger trains have ceased to run on the Atlantic Avenue line of the Long Island Railroad, and the service between Flatbush avenue, Brooklyn, and Belmont Park and Rockaway Beach is now entirely electric. Freight will be hauled by steam until electric freight-train motors, already ordered, arrive.

FAIRMOUNT, W. VA.—The county court of Marion County has granted two electric railway franchises—one to the Fairmount & Morgantown Traction Company, and the other to the Fairmount & Fairview Traction Company. Construction must be begun within one year, and the roads completed within two and one-half years.

MARYSVILLE, OHIO—Indications now are that the Columbus, Urbana & Western electric road, which is in the hands of the Schoepf syndicate, will be built through Union County. The line is already constructed and in operation about half the distance between Columbus and Urbana. The original plan was to build the road *via* Dublin, Plain City, Rosedale and Mechanicsburg, but this has been changed with a view of extending the road to Bellefontaine.

SALT LAKE CITY, UTAH—The county commissioners have passed an ordinance granting to J. F. McCarron a franchise to operate an electric railway in Webster County. Although the franchise affects the county alone, it is understood that the proposed line is to become a part of the Eccles roads, connecting at the southern limits of the city with the line of the Ogden Rapid Transit Company's tracks and at the northern limits of the city with the tracks of the Ogden & Northwestern line, which now extend to the Hot Springs. Intention, it is believed, is to build a line from Salt Lake to Ogden, thence north to Logan, thereby fulfilling the statements made some time ago that such a line would be built by the Eccles people. It is also stated that the Utah Light and Power Company will be a factor in the deal.

TELEPHONE AND TELEGRAPH.

EATON, OHIO—The Eaton Telephone Company is constructing a direct line to Dayton.

WHEELING, W. VA.—The Bell Telephone Company has completed its line to Sherrard.

UTICA, MISS.—A telephone line has been completed between Utica and Bear Creek, Miss.

DELTA, N. Y.—The Bell Telephone Company is extending a line from Rome to Delta, *via* Elmer Hill.

TROY, N. Y.—The Hudson River Telephone Company has purchased the Kingsbury-Hartford telephone line.

BOWLING GREEN, OHIO—The Wood County Telephone Company has absorbed the Home Telephone Company, of North Baltimore.

SOUTH McALESTER, I. T.—The Pioneer Telephone Company has purchased what is believed to be a controlling interest in the South McAlester-Eufaula telephone system.

TAYLORVILLE, ILL.—A new county telephone company has been organized with a capital stock of $10,000. The incorporators are W. H. Jones, G. D. Winters, J. C. McBride, D. W. Johnson.

BRIDGEPORT, CT.—The Southern New England Telephone Company is making arrangements to put all of its toll line wires underground, between New York and New Haven, in the spring.

JEFFERSONVILLE, IND.—To relieve the pressure on the local service the Cumberland Telephone and Telegraph Company has decided to establish an exchange at Utica, and work will be begun at once.

AUSTIN, TEX.—The Southwestern Telegraph and Telephone Company has filed its statement with the comptroller for the quarter ending September 30, showing the gross receipts for that period to have been $558,573.84, exclusive of $24,412.59 obtained from lease of wires.

READING, PA.—The farmers' telephone line in the lower end of Berks County is to be extended from Schultz's mill, near Niantic, to Barto, and thence to Huff's Church, *via* Forge Dale. The new route will be about nine miles in length and will traverse a thickly populated section.

OAKLAND, CAL.—A permit has been issued to the Pacific States Telephone and Telegraph Company by the board of public works to make the necessary excavations to install the extension of its underground system. The company is allowed 150 days in which to complete the work, which will cost about $125,000.

RICHMOND, VA.—It has been announced that the telegraph lines along the route of the Farmville & Powhattan Railroad have passed into the control of the Postal Telegraph company. The name of the road hereafter will be the Tidewater & Western. Stations will be erected by the Postal company at the following points: Farmville, Cumberland Courthouse, Tobaccoville, Ballsville, Powhattan Courthouse, Beach, Moseley, Chester, Winterpock, Bermuda, Adriance, Bellona, Charlotte Courthouse, Clemontown, Deatonsville, Hampden-Sidney, Macon, McRees, Rival, Roseney, Stoddart, Sunnyside, White Hall and Worhshams. In addition to the work of the railroad company, the Postal will also handle commercial work at these points.

PHILADELPHIA, PA.—The Keystone Telephone Company is making extensive improvements to its system. In response to the demand for additional telephone service, work of extension has been rapidly pushed. Additional conduits have been laid in the northwestern part of the city and in the Manayunk district, and extensions will be made to Chestnut Hill. A large force of men is already at work in West Philadelphia and the switchboard of that exchange has been extended. The West Philadelphia section has been built up so rapidly that the conduit system will have to be extended from the present termini, which is about Fiftieth street, west on all the principal thoroughfares to the city line. Nearly $200,000 worth of additional cable has been ordered and about two-thirds of it has been installed in the conduits and will be put in service at an early day. The Keystone State Telephone and Telegraph Company is also doing a great deal of extension work in the surrounding counties. A line has been completed to Newtown, Bucks County, and a new exchange installed at that place. Three additional exchanges at suburban points will shortly be established.

INDUSTRIAL ITEMS.

THE AUTO-COIL COMPANY, Jersey City, N. J., is marketing a complete line of ignition apparatus for gasoline engine service, and a line especially adapted for auto work.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., has recently closed a contract with the Arbuckle-Ryan Company, of Toledo, Ohio, for two 250-kilowatt, engine-type, alternating-current generators, for installations at Canton, Ohio.

THE COUCH & SEELEY COMPANY has removed to the Vermont Building, 10 Thacher street, Boston, Mass. This new address is convenient to the North station and to the Haymarket square subway station, as well as to the North station surface cars.

THE BROWN & SHARPE MANUFACTURING COMPANY, Providence, R. I., has issued catalogue No. 107, giving price lists of machinists' tools. A very complete index is appended. The company also manufactures milling machines, grinding machines, gear-cutting machines, screw machines, and cutters.

G. M. GEST, the expert subway contractor, New York and Cincinnati, has been awarded the contract for the construction of a complete subway system at Chattanooga, Tenn., for the East Tennessee Bell Telephone Company. Active work has been commenced and is to be rushed to a speedy conclusion. This is the first conduit work installed in the city of Chattanooga, and the system will be a large one.

STANLEY & PATTERSON, INCORPORATED, 40 Cortlandt street, New York city, has been mailing to the trade an extremely bright series of literature devoted to the "Faraday" pivoted armature skeleton bell. This circular matter has been so unique in design and expression, that the increase in the sale of this type of bell may readily be explained by those who realize the full value of effective advertising.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., manufacturer of Christensen air brakes, air-compressors and electrical machinery, has opened a Cleveland office at 416 Electric Building, in charge of Mr. George S. Hastings, who will handle the complete line throughout Ohio, Indiana, Michigan, West Virginia and New York as far east as Schenectady, and electrical machinery only in Pennsylvania as far east as Johnstown.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed contracts for switchboards for the following places: Varna, Ill.; Urich, Mo.; Bouton, Iowa; Atalissa, Iowa; Leonard, Mich.; Stuttgart, Kan.; Stromsburg, Neb.; Stelhensport, Ky.; Yates City, Ill.; Friendly, W. Va.; Sistersville, W. Va.; New Matamoras, Ohio; Laclede, Mo.; Long Lake, Minn.; Eureka, Utah; Payson, Utah; Richmond, Utah; Tooele, Utah; Preston, Ida.; Lowville, N. Y.; Louisville, Ky.; Attica, Ind.; Rochester, N. Y.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has received an order from the Chicago Edison Company for two 8,000-kilowatt Curtis steam turbines and generators. These machines are each capable of developing 18,000 horse-power. This order is a duplication of one formerly received from the Chicago Edison Company for two similar machines. The New York Edison Company has also recently ordered two machines of same size. These are the largest steam turbines ever designed, the six units referred to being capable of producing a total of 108,000 horse-power. The Chicago Edison Company has very recently started up its fourth Curtis turbine unit of 5,000-kilowatts capacity. The new company was the first to install and operate a Curtis turbine of this size.

THE ELECTRO-DYNAMIC COMPANY, New York city, is preparing an interesting exhibit for the New York Electrical Show to be held December 12 to 23. One of the features of this exhibit will be an "Interpole" motor driving another as a generator, the current to be used in the electric illumination of the company's booth. Practical demonstrations will be made of the fact that the "Interpole" motor can be overloaded 100 per cent without sparking, and instantly reversed still without sparking. Another feature of the exhibit will consist of a display of the different sizes of frames, showing how small and light the "Interpole" motor is in proportion to its power. The ball-bearings, which add so much to the efficiency of this type of motor, will also be shown. Demonstrations of the Maloney transformers will be made, to show the high efficiency and low iron and idle-load loss.

THE TRAY PLATE BATTERY COMPANY, Binghamton, N. Y., recently completed a storage battery installation for the Curtis-Blaisdell Company, and tests of this plant will be made in the near future, as a new generator has recently been put into position. The company is now erecting a complete battery installation at Jamestown, R. I., at the residence of Mr. J. P. Henzsey, who is one of the officers of the Baldwin Locomotive Works at Philadelphia, Pa. The company has also completed and put in service a small plant at Middlebush, N. J., and is erecting a fairly large battery at Titusville, Pa. It is about to ship a large battery to Pittsburg, Pa., and within the next ten days another equipment will be sent to Lake George for the residence of Mr. George Foster Peabody. Still another battery is to go to Manchester, N. H. It will be seen from these orders that the Tray Plate Battery Company is meeting with unusual success.

THE FISHKILL LANDING MACHINE COMPANY, Fishkill-on-the-Hudson, N. Y., has just issued a new catalogue which will be of interest to steam power users generally. In this catalogue are shown the various styles of Corliss engines built by the company. The book is attractively designed and printed, and finely illustrated throughout, and contain much valuable information for those in charge of modern steam plants. In addition to a complete description of the engines built, an interesting series of illustrations is presented, showing the integral parts, especially the type of valve gear and vacuum pots which have contributed to the success of the Fishkill type of Corliss engine. An excellent list of references by users of this company's engines is also appended, endorsing the efficiency of the engines as to economy, close regulation and noiseless operation. The Fishkill company will be glad to send copies of this catalogue on application.

THE DE LA VERGNE MACHINE COMPANY, New York city, which recently completed contracts for 40,000 horse-power of Koerting two-cycle, double-acting gas engines, of which 32,000 horse-power is employed for driving blowing engines and 8,000 horse-power for driving direct-current and polyphase alternating-current generators, has recently been given a contract for three 500-horse-power Koerting gas engines to be direct-connected to 325-kilowatt, 550-volt, direct-current, Crocker-Wheeler generators for the Boston Elevated Railway Company. These engines will be put in operation about January 1, 1906. Owing to its rapidly increasing southern business, the De La Vergne Machine Company has established a branch agency at 510 Candler Building, Atlanta, Ga. This agency is to cover the states of North Carolina, South Carolina, Alabama, Florida and Georgia, and will handle business connected with the three lines of machinery manufactured by the De La Vergne company, *viz.*: refrigerating and ice-making machinery, "Hornsby-Akroyd" oil engines, and Koerting gas engines. The company's representative will be Mr. W. M. Hargreaves.

THE CHICAGO & NORTHWESTERN RAILWAY COMPANY is planning the construction of a line across Wyoming through a large section which is now without railway facilities. This will carry the line directly across the central portion of Wyoming to the Big Horn river, across that stream and through what is at present the Wind River Indian Reservation to the beautiful Lander valley, opening up thousands of square miles in the range country, and furnishing railway facilities to the Wind River Reservation where more than a million acres of public land will be thrown open to the homesteader by the government next June. The new line across Dakota will effect a junction with the old line at Rapid City, and this will give Pierre and the range country an impetus beyond anything that has ever been done for this region. The great benefits of this are apparent when it is realized that the Northwestern Railroad will give added railway facilities to this section of the country in connection with St. Paul, Minneapolis and Duluth, with the lake Superior iron and copper country. The Chicago & Northwestern Railway is also constructing several different branches, one northwest from Mercer; one from Manitowoc on lake Michigan, through Green Bay, another important lake port, north into the heart of the hardwood district; another link extending from Laona, Wis., to the Menominee river at Saunders, Mich.; a branch line from Green Bay to Gillett. From a manufacturing and industrial standpoint, this great amount of construction work will have an important bearing in the very near future.